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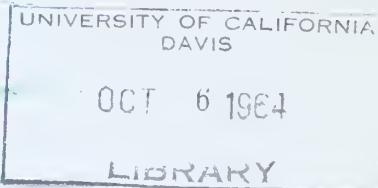


THE RESOURCES AGENCY OF CALIFORNIA

Department of Water Resources

BULLETIN No. 24-60

COASTAL LOS ANGELES COUNTY  
LAND AND WATER USE  
SURVEY, 1960



HUGO FISHER

Administrator

The Resources Agency of California

EDMUND G. BROWN

Governor

State of California

WILLIAM E. WARNE

Director

Department of Water Resources

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Spence Air Photos

Downtown Los Angeles  
The heart of a sprawling metropolis

State of California  
THE RESOURCES AGENCY OF CALIFORNIA  
Department of Water Resources

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MARCH 1964

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*Administrator*  
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EDMUND G. BROWN  
*Governor*  
State of California

WILLIAM E. WARNE  
*Director*  
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WILLIAM E. WARNE  
Director of  
Water Resources  
  
ABBOTT GOLDBERG  
Chief Deputy Director  
  
REGINALD C. PRICE  
Deputy Director Policy  
  
NEELY GARDNER  
Deputy Director  
Administration  
  
ALFRED R. GOLZÉ  
Chief Engineer

EDMUND G. BROWN  
GOVERNOR OF  
CALIFORNIA

HUGO FISHER  
ADMINISTRATOR  
RESOURCES AGENCY

ADDRESS REPLY TO  
P. O. Box 388  
Sacramento 2, Calif.



THE RESOURCES AGENCY OF CALIFORNIA  
DEPARTMENT OF WATER RESOURCES

1120 N. STREET, SACRAMENTO

April 9, 1964

Honorable Edmund G. Brown, Governor,  
and Members of the Legislature of the  
State of California  
State Capitol  
Sacramento, California

Gentlemen:

I have the honor to transmit herewith Department of Water Resources Bulletin No. 24-60, entitled "Coastal Los Angeles County Land and Water Use Survey, 1960." The report has been prepared as a part of the department's continuing program of studies of the use of the water resources of the State to provide the basis for planning water development, pursuant to Sections 225, 226, and 232 of the California Water Code.

The report presents data concerning land use and estimates of water use thereon as of 1960, and evaluates the changes in land and water use since the last survey of the area was made in 1955. This information will be useful to those agencies concerned with making the most effective use of existing water supplies and in development of plans for additional water supplies to support the increasing population.

The results of the 1960 survey of land and water use in Coastal Los Angeles County indicate that during the period from 1955 through 1960 the gross water service area increased from 550,900 acres in 1955 to 609,600 acres in 1960, a growth of 58,700 acres or about 11 percent. Population in the same area increased from 5,033,611 to 5,958,823, or about 18 percent. A direct result of the population growth has been expansion in the gross urban and suburban area by 107,200 acres, or 23 percent, while the estimated gross irrigated area was reduced by 48,500 acres. The estimated mean seasonal level of total net water use in Coastal Los Angeles County increased from about 955,000 acre-feet in 1955 to 1,073,000 acre-feet in 1960, an increase of 118,000 acre-feet, or about 12 percent.

Honorable Edmund G. Brown, Governor,  
and Members of the Legislature of the  
State of California  
State Capitol  
Sacramento, California

The increasing need for water in Coastal Los Angeles County,  
coupled with already deficient local water supplies in many localities,  
demands participation by residents of this area in statewide planning  
and construction of water resources developments.

Sincerely yours,



Director

## AUTHORIZATION

The California Legislature of 1929 enacted legislation providing for investigations of this kind as follows:

"Out of any money in the state treasury not otherwise appropriated, the sum of four hundred fifty thousand dollars,\* or so much thereof as may be necessary, is hereby appropriated to be expended by the state department of public works in accordance with law in conducting work of exploration, investigation and preliminary plans in furtherance of a coordinated plan for the conservation, development and utilization of the water resources of California including the Santa Ana River and its tributaries, the Mojave river and its tributaries, and all other water resources of southern California." (California statutes of 1929, Chapter 832, Section 1).

\*Reduced by the Governor to \$390,000.

Subsequent sessions of the Legislature have appropriated funds for support of the Division of Water Resources and the Department of Water Resources. Portions of these funds have been used for continuing investigations of the water resources of Southern California, in accordance with the legislative intent expressed in the foregoing statute and in Sections 225 and 226 of the California Water Code.

In 1956 the Legislature further directed the Department of Water Resources to make continuing investigations to develop "information as to water which can be made available for exportation from the watersheds in which it originates without depriving those watersheds of water necessary for beneficial uses therein." This legislation specifically requested investigation of the following matters:

"(a) The boundaries of the respective watersheds of the state and the quantities of water originating therein; (b) The quantities of water reasonably required for ultimate beneficial use in the respective watersheds; (c) The quantities of water, if any, available for export from the respective watersheds;

and (d) The areas which can be served by the water available for export from each watershed; (e) The present uses of water within each watershed together with the apparent claim of water right attaching thereto, excluding individual uses of water involving diversions of small quantities which, in the judgment of the Director of Water Resources, are insufficient in the aggregate to materially affect the quantitative determinations included in the report." (California statutes of 1956, First Extra Session, Chapter 61; Water Code Section 232).

#### ACKNOWLEDGMENT

Valuable assistance and data for this investigation and report were contributed by numerous public agencies whose cooperation is gratefully acknowledged. In this regard, special mention is made of the assistance and data received from the following:

Los Angeles County Regional Planning Commission

Los Angeles County Engineer's Office

United States Forest Service

Los Angeles County Flood Control District

The Metropolitan Water District of Southern California

Los Angeles Department of Water and Power

STATE OF CALIFORNIA  
THE RESOURCES AGENCY OF CALIFORNIA  
DEPARTMENT OF WATER RESOURCES

EDMUND G. BROWN, Governor  
HUGO FISHER, Administrator, The Resources Agency  
WILLIAM E. WARNE, Director, Department of Water Resources  
ALFRED R. GOLZE', Chief Engineer  
JOHN R. TEERINK, Assistant Chief Engineer

---

SOUTHERN DISTRICT

James J. Doody . . . . . District Engineer  
Herbert W. Greydanus . . . . . Chief, Planning Branch

---

This investigation and the preparation of this report  
were conducted under the direction of

Donald H. McKillop . . . . . Chief, Water Supply and Utilization Section

and

Ronald G. Hansen . . . . . Senior Engineer, Water Resources  
Elwood C. Johnson . . . . . Water Resources Engineering Associate

by

Robert D. Smith . . . . . Assistant Land and Water Use Analyst

assisted by

Barry P. Brown . . . . . Assistant Land and Water Use Analyst  
L. Eugene Fouquette . . . . . Assistant Land and Water Use Analyst  
Sumi Minatoya . . . . . Delineator





Long Beach Harbor  
A shipping point for world trade

Spence Air Photos

## CHAPTER I. INTRODUCTION

El Pueblo de Nuestra Senora la Reina de Los Angeles de Porcun-cula was founded in 1781 on the banks of a flowing river. Water from the river and shallow-dug wells provided an ample supply for all the needs of this new settlement. In the ensuing 179 years, however, this small village has grown into the sprawling metropolitan complex of the City and County of Los Angeles, whose inhabitants have long since ceased to rely on the uncertain flow of that river for their diverse water needs.

By 1960, nearly 6 million persons were living in Coastal Los Angeles County. This 1,900 square-mile area has become one of the most populous urban regions in the nation, and its water requirements have grown apace with the construction of its industrial, commercial, and residential tracts.

This report indicates the direction and magnitude of the growth occurring in Coastal Los Angeles County between 1955 and 1960. Information on land and water use in this area is presented herein which can be used by responsible agencies and individuals in planning for the most effective use of existing water supplies and for developing additional supplies for current and projected needs.

### Scope of Investigation and Report

A comprehensive field survey was conducted during the summer of 1960 by the Department of Water Resources to determine the nature and extent of land and water use within Coastal Los Angeles County. Data from that survey, from related investigations and reports, and from material in the department's files were used in the compilation of this report.

The location and boundaries of the area of investigation are shown on Plate 1, "Area of Investigation." The area surveyed is similar in extent to that surveyed in 1955, reported in Bulletin No. 24, "Los Angeles County Land and Water Use Survey, 1955," published by the State Water Resources Board. However, the present study also includes all of the San Gabriel Mountain drainage area tributary to Coastal Los Angeles County.

#### Related Investigations and Reports

The California Legislature, by Chapter 1541, Statutes of 1947, appropriated funds for predecessor agencies of the Department of Water Resources to conduct a comprehensive investigation of the water resources of the entire state. The results of this investigation were used in the preparation of the California Water Plan and are presented in three bulletins: Bulletin No. 1, "Water Resources of California," and Bulletin No. 2, "Water Utilization and Requirements of California," published in 1951 and 1955, respectively, by the State Water Resources Board; and Bulletin No. 3, "The California Water Plan," published by the Department of Water Resources in May 1957.

The investigation leading to publication of Bulletin No. 2 included a survey of land and water use in the South Coastal area during 1950. The South Coastal area encompasses Coastal Los Angeles County, and in 1955 data from this earlier investigation were used as a basis for comparison in preparing Bulletin No. 24.

Definitions of terms used in this bulletin are presented in Appendix A and a list of additional reports that contain information on land and water use in Coastal Los Angeles County will be found in Appendix B.

#### Area of Investigation

Information pertinent to the interpretation of land use data, such as the location and description of the investigational area, hydrologic units, population, agricultural and urban-suburban development, and water supply and disposal are presented in this section.

#### Location and Description

The present investigation encompasses all of Los Angeles County south of the San Gabriel Mountain Drainage Divide. It includes an area of about 1,930 square miles with an average north-south dimension of about 35 miles and a width of about 60 miles, as shown on Plate 2, "Hydrologic Units and Subunits." The area is composed of the inland San Fernando and San Gabriel Valleys which are separated from the Los Angeles Coastal Plain by a range of hills crossing the area in a southeasterly direction from the Santa Monica Mountains to the Chino Hills. Elevations within the investigational area range from sea level to over 10,000 feet.

There are three major streams which drain the area of the investigation: the Los Angeles River, the Rio Hondo, and the San Gabriel River. The Los Angeles River drains the San Fernando Valley and flows southerly through the Los Angeles Narrows into the coastal plain where it then enters San Pedro Bay at Long Beach. The Rio Hondo drains the San Gabriel Mountains and San Gabriel Valley, then flows through the Whittier Narrows and follows a southwesterly direction where it joins the Los Angeles River about 12 miles

upstream from the ocean. Similar to the Rio Hondo, the San Gabriel River conveys water from the San Gabriel Mountains and San Gabriel Valley through the Whittier Narrows. It then flows southerly until it enters the ocean near Seal Beach. These principal stream systems, together with other minor streams including Malibu, Topanga, and Ballona Creeks, enter the Pacific Ocean along a 65-mile coastline between Ventura and Orange Counties.

The three main valleys or basin groups described above are filled with absorptive alluvial or marine deposits of recent origin underlain and generally surrounded by relatively impervious rock formations. Important soil types found in Coastal Los Angeles County include those of Yolo, Hanford, Tujunga, Pomona, and Chino series.

Alluvial deposits in the area are faulted and folded, with the result that hydraulic continuity between adjacent water-bearing formations is limited, thereby creating several distinctly identifiable ground water basins. With the exception of portions of the Los Angeles Coastal Plain, all ground water basins are considered to be generally unconfined. Penetration of rainfall and percolation of streamflow to ground water in some coastal plain basins is restricted by the presence of clay strata of low permeability which overlie the important pumped aquifers. The principal areas of replenishment of surface streamflow and precipitation to these semiconfined aquifers are along the general location where they emerge at the ground surface in the forebay areas below Los Angeles and Whittier Narrows, although some replenishment probably occurs from deep percolation directly through the overlying clay strata.

Precipitation varies widely both seasonally and monthly, and is subject to wide extremes of occurrence over localized areas. Precipitation

generally occurs as rainfall, although the peaks of the San Gabriel Mountains are capped with snow during some winter months. Rare snowfalls have also been recorded throughout most of Coastal Los Angeles County. Mean seasonal precipitation varies from approximately 12 inches along the coast to more than 25 inches along portions of the mountainous northern boundary of the area. With the exception of the Santa Monica Mountains, little increase in precipitation with increase in elevation occurs over the intermediate belt of hills separating the inland valleys from the coastal plain. The 50-year mean seasonal precipitation at Los Angeles, for the period 1897-98 through 1946-47, was 14.81 inches.

Mean temperature at Los Angeles is about 63° F. contributing to a climate suitable for truck crops. Damaging winds and frost are rare and occur for short periods only. Loss of subtropical crops is usually prevented during heavy frosts by use of orchard heaters or wind-making machines.

#### Hydrologic Units

For study purposes, Coastal Los Angeles County has been divided into six component hydrologic units, based primarily upon topographic and geologic considerations. Each hydrologic unit has been further divided into subunits which act as secondary areas within the unit and serve to facilitate studies that may arise in a hydrologic analysis. Hydrologic units, designated the Los Angeles Coastal Plain Unit, San Fernando Unit, San Gabriel Unit, Upper Santa Ana Valley Unit, Malibu Unit, and the Orange County Coastal Plain Unit, along with component subunits, are depicted on Plate 2. The gross areas of these units are presented in Table 1.

TABLE 1

AREAS OF HYDROLOGIC UNITS IN  
COASTAL LOS ANGELES COUNTY

Hydrologic unit	:	Area, in acres
Los Angeles Coastal Plain		392,270
San Fernando		322,790
San Gabriel		368,950
Upper Santa Ana Valley		38,330
Malibu		100,190
Orange County Coastal Plain		<u>11,660</u>
TOTAL		1,234,190

Geologically and topographically certain of the units enumerated in the previous paragraph are parts of larger units which also include areas outside of Los Angeles County. The Orange County Coastal Plain Unit is a small part of a major unit lying primarily in Orange County and in a similar manner the Upper Santa Ana Valley Unit is part of the Chino Basin of San Bernardino County. These partial units have been included in this report in order to provide a complete picture of Coastal Los Angeles County. On the other hand, small portions of the Malibu and San Fernando Units lie in Ventura County. Although the land use data for the Ventura County portions are excluded from the tables presented in the text, these land use data have been included in the tables presented in Appendix C to provide complete information for purposes of hydrologic studies.

Certain minor adjustments have been made in the unit boundaries presented in this report from those presented in Bulletin No. 24, primarily

as the result of major investigations conducted subsequent to the earlier publication. The Orange County Coastal Plain Unit was considered part of the Los Angeles Coastal Plain Unit in the earlier publication while Topanga Canyon Hydrologic Subunit, formerly within the Los Angeles Coastal Plain Hydrologic Unit, has been included in the Malibu Unit. A portion of the Los Angeles Narrows Subunit, previously within the Los Angeles Coastal Plain Unit, was transferred to the San Fernando Hydrologic Unit. In addition to the foregoing, a major portion of the San Gabriel Mountains south of the drainage divide, formerly excluded from the Bulletin No. 24 investigational area has been included in this report.

#### Population

The U. S. Bureau of the Census determined the population of Coastal Los Angeles County to be 5,958,823 in 1960. This represents an increase of about 44 percent over the 1950 population of 4,121,712 and an increase of about 18 percent over the 1955 Los Angeles County Regional Planning Commission estimate of 5,033,611. It is estimated by the Los Angeles County Planning Commission that the coastal county area population will increase to 6,800,000 persons by the year 1965 and that beyond that date increases will occur steadily, but at a declining rate. The historical population increases in Coastal Los Angeles County and in the City of Los Angeles from 1880 to 1960 are shown graphically on Plate 3, "Historical Population and Land Use in Coastal Los Angeles County."

Population increases within Coastal Los Angeles County appear to follow a balanced peripheral pattern with growth occurring at relatively the same rate at different radii from the central Los Angeles area. The

Los Angeles County Regional Planning Commission has stated in their quarterly bulletin of July 1962 that the 1960 population center of Coastal Los Angeles County has moved only one-half mile from the 1930 location. An average population increase of about 32 percent has been recorded since 1950 by the 28 largest cities within the investigational area. Table 2 presents the 1940, 1950, and 1960 population figures for each of these 28 cities.

#### Agricultural Development

Soon after the founding of Los Angeles in 1781, the first large land grants, such as the San Pedro, Los Metos, and San Rafael, were made by the Spanish government, and these were followed by other grants of like nature. Stock raising soon became the chief industry and remained such for nearly half a century. The earliest Spanish settlers occupied land along the main streams which could be easily irrigated, and grapes, peaches, figs, olives, apricots, pears, quinces, and some oranges were among the earliest crops. However, agricultural expansion was slow prior to 1850, and was mainly confined to the activities of the Mission Fathers and their converts. The entry into Los Angeles of the Southern Pacific Railroad in 1874 and the Atchison, Topeka, and Santa Fe Railroad in 1885, was followed by rapid settlement and agricultural development.

The introduction of the deep well turbine pump greatly stimulated the development of irrigated agriculture in Coastal Los Angeles County. By 1926, there were approximately 209,000 acres under irrigation. Urban development has since encroached on lands suitable for agriculture and this type of land use is rapidly diminishing in importance. As late as 1950,

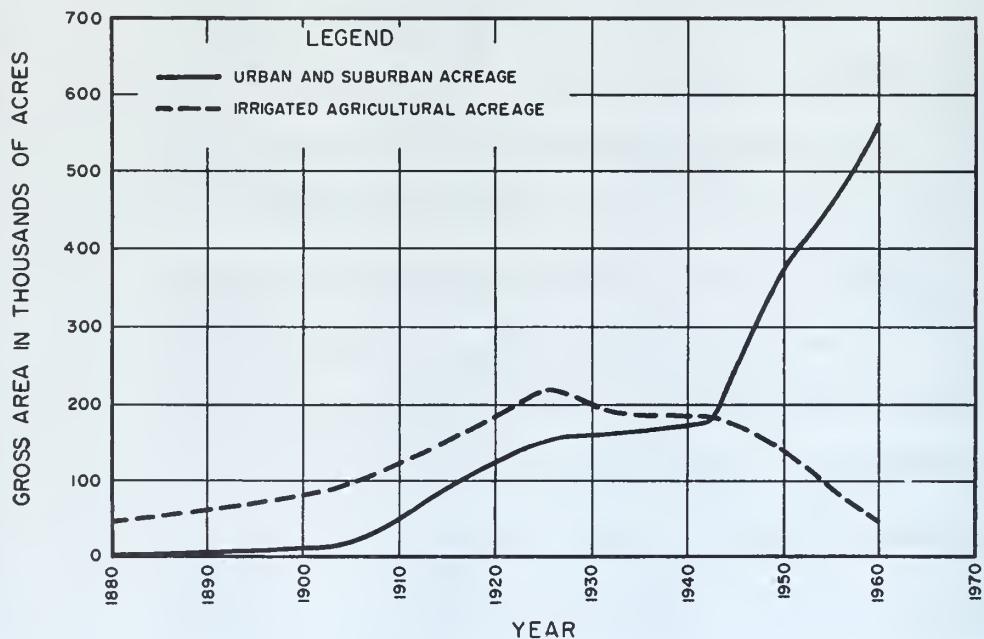
TABLE 2  
POPULATIONS OF PRINCIPAL CITIES IN  
COASTAL LOS ANGELES COUNTY

City	Population*			Percent increase 1950-60
	1940	1950	1960	
Alhambra	38,935	51,359	54,807	7
Arcadia	9,122	23,066	41,005	78
Baldwin Park	Incorporated Jan. 25, 1956		33,957	--
Bellflower	Incorporated Sept. 3, 1957		45,909	--
Beverly Hills	26,823	29,032	30,817	6
Burbank	34,337	78,577	90,155	15
Compton	16,198	47,991	71,812	50
Culver City	8,976	19,720	32,163	63
Downey	Incorporated Dec. 17, 1956		82,505	--
Gardena	5,909	14,405	35,943	150
Glendale	82,582	95,702	119,442	25
Huntington Park	28,648	29,450	29,920	2
Inglewood	30,114	46,185	63,390	37
Lakewood	Incorporated Apr. 16, 1954		67,126	--
Long Beach	164,271	250,767	334,168	33
Los Angeles	1,504,277	1,970,358	2,479,015	26
Manhattan Beach	6,398	17,330	33,934	96
Monterey Park	8,531	20,395	37,821	85
Norwalk	Incorporated Aug. 25, 1957		88,739	--
Pasadena	81,864	104,577	116,407	11
Pico Rivera	Incorporated Jan. 29, 1958		49,150	--
Pomona	23,539	35,405	67,157	90
Redondo Beach	13,092	25,226	46,986	86
Santa Monica	53,500	71,595	83,249	16
South Gate	26,945	51,116	53,831	5
Torrance	9,950	22,241	100,991	354
West Covina	1,072	4,499	50,645	1,026
Whittier	16,115	23,433	33,663	44

\* U. S. Bureau of the Census.

Coastal Los Angeles County was the second largest producer of citrus fruits in the State. Today, however, five citrus-producing counties exceed Los Angeles in acreage, and by 1970, it is predicted that Los Angeles

County will have the smallest citrus acreage of any citrus-producing county in Southern California. In 1940, Los Angeles County had the greatest acreage of deciduous fruit and nut crops in Southern California. Today, these crops are of only minor importance in the county's farm economy. Field and truck crop acreages have also decreased considerably since 1940 and will continue to lose acreage to urban expansion. Figure 1 graphically illustrates the uniform growth of agriculture and urban-suburban development to the 1920's, at which time agriculture started to decline. The urban-suburban explosion subsequent to 1940 is also indicated.



HISTORICAL LAND USE IN COASTAL LOS ANGELES COUNTY

FIGURE 1

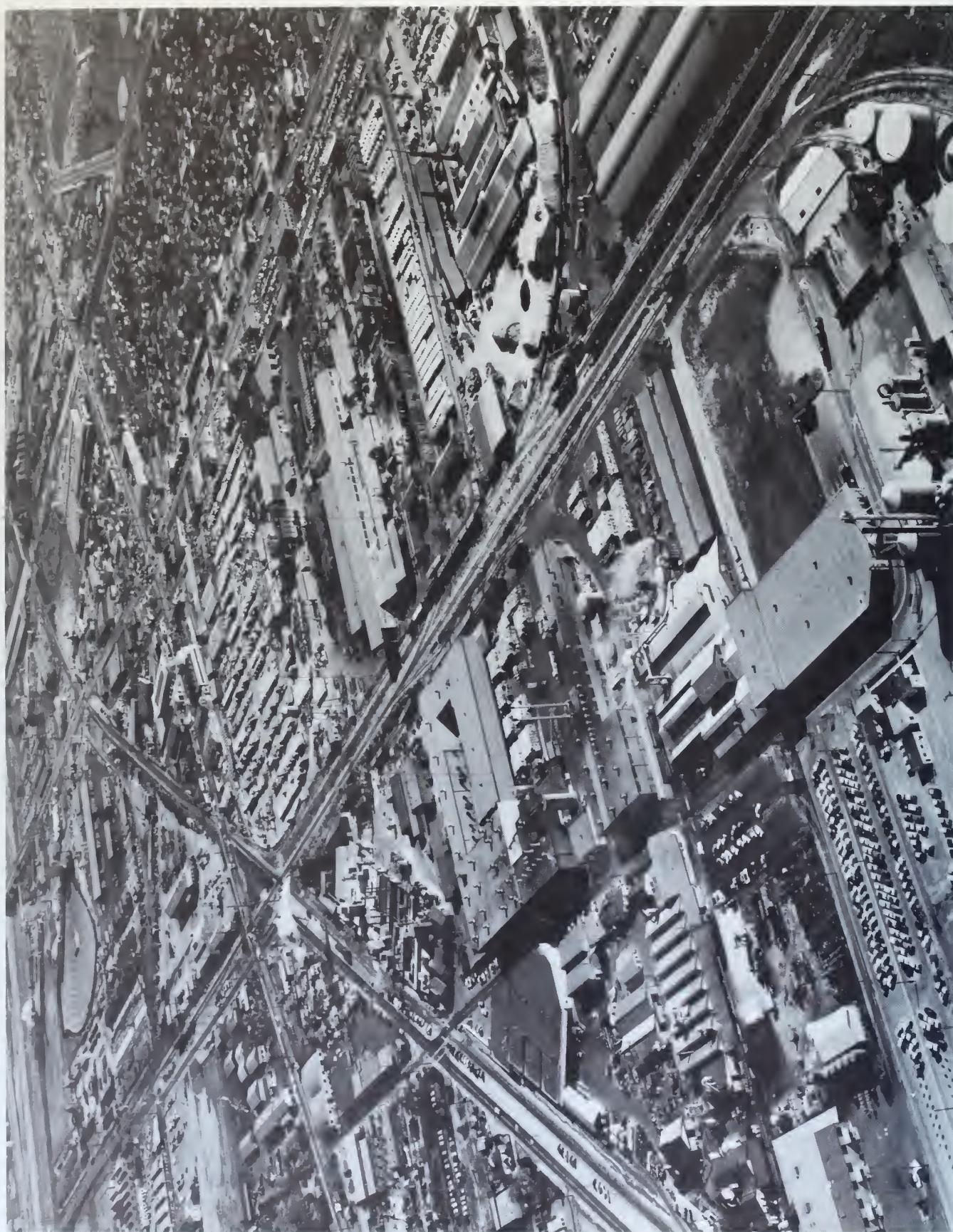
A mass curve depicting the historical uses of land, including agricultural use, is presented on Plate 3.

## Urban and Suburban Development

The dramatic increase in population in Coastal Los Angeles County which has occurred since about 1940 has had an explosive effect on the demand for housing. This has resulted in conversion of an average of about 25,000 acres per year to urban-suburban development as indicated by Plate 3 and Figure 1. As time passed the problem of availability of land has necessitated that this development must occur farther and farther from the center of the city. It is evident that eventually a shortage of land, which is suitable for this type of development, will dictate a changeover from single to multiple housing units.

The effect described above is becoming manifest, for since 1955, both urban and commercial complexes have changed considerably within Coastal Los Angeles County. There appears to be a trend toward an increase in apartments within older residential districts. In 1955, 72 percent of the Los Angeles County residential building permits were of the single type, whereas in 1960 these had dropped to 42 percent. There has been an increase in commercial construction within established downtown-type areas; many new multistory office buildings have been completed or are under construction in these areas at the present time. There has also been a proliferation of suburban shopping centers in the outlying areas of the county.

Los Angeles County remains the industrial center of Southern California's economy and continues to be a leading producer of aerospace and missile products, electronic devices, transportation equipment, electrical machinery, food products, fabricated metals, clothing, and printing and publishing items. Many of these products are now produced in large industrial parks which have been constructed in former residential or



agricultural areas, usually at some distance from the older and more congested industrial districts.

#### Water Supply

The water supply for Coastal Los Angeles County is derived from two principal sources: ground water extracted from the extensive basins which prevail in the county and by imports delivered through aqueducts from the Owens Valley and the Colorado River. Although some water is derived from surface diversions of local runoff and rising water, the erratic nature and limited volume of this source of water has precluded its use as a major supply. The boundaries of the major water agencies within the investigational area are shown on Plate 4, "Major Water Agencies."

Local Supply. Although 19th century water using development in Coastal Los Angeles County was based upon surface diversions, water extracted from the permeable deposits of the extensive ground water basins which underlie the area became the chief source of supply shortly after the turn of the century and has remained so to the present time. The locations of these ground water basins are delineated on Plate 2.

Exploitation of the ground water basins has been such that ground water overdraft conditions, or excess of net extractions of ground water over replenishment, have prevailed and have developed in magnitude in certain portions of the area of investigation since the early 1900's. These conditions have continued in ever-increasing intensity to the present time. Sea-water intrusion into coastal pumped aquifers was noted as early as 1912, when perceptible quantities of saline water were pumped from wells in the Redondo Beach area, and the inland encroachment of the saline front has

continued to the present time. In recent years, many local water agencies and individuals have been very active in efforts to reduce overdraft conditions through litigation and voluntary control of extractions in combination with increased use of imported supplies and through stepped-up replenishment activities.

The approximate magnitude of the local water supply, herein called the safe yield of local supplies, is estimated to be about 374,000 acre-feet annually based on studies conducted by the State Water Rights Board in connection with the report entitled "San Fernando Valley Reference Report"; the Department of Water Resources reports entitled "The Raymond Basin Reference," and Bulletin No. 104, "Planned Utilization of Ground Water Basins of the Coastal Plain of Los Angeles County"; and from other information in the files of the Department of Water Resources. This safe yield of local water supplies represents the approximate magnitude of the average seasonal volume of water derived from local sources, precipitation and surface runoff, which is available for application to satisfy the net water uses. It excludes the effects of the historical importation of water from outside the county. This estimate, which varies slightly from the value presented in Bulletin No. 24, is based upon more recent and more comprehensive geologic and hydrologic studies of the ground water basins of the coastal portion of the county.

Imported Supply. The inadequacy of local water supplies to meet needs of the area was recognized prior to 1900, and the City of Los Angeles initiated studies leading to the construction of an aqueduct to import water from the Owens River Basin and later to tap waters of the Mono Lake

TABLE 3

HISTORICAL SEASONAL DELIVERIES OF IMPORTED WATER  
TO COASTAL LOS ANGELES COUNTY

In acre-feet

Season ending September 30	: Los Angeles Aqueduct	: Colorado River Aqueduct	: Total
1929-30	198,100	--	198,100
31	215,800	--	215,800
32	238,200	--	238,200
33	228,400	--	228,400
34	185,600	--	185,600
1934-35	194,900	--	194,900
36	237,000	--	237,000
37	206,700	--	206,700
38	209,100	--	209,100
39	237,300	--	237,300
1939-40	217,200	--	217,200
41	201,000	4,900	205,900
42	246,400	10,800	257,200
43	264,400	6,700	271,100
44	274,500	18,500	293,000
1944-45	267,200	25,800	293,000
46	284,000	44,200	328,200
47	291,000	53,700	344,700
48	306,500	61,500	368,000
49	298,500	61,900	360,400
1949-50	305,400	54,700	360,100
51	317,400	73,700	391,100
52	316,600	76,000	392,600
53	320,900	95,000	415,900
54	318,600	139,200	457,800
1954-55	316,300	153,500	469,800
56	321,300	205,900	527,200
57	318,400	223,500	541,900
58	325,400	262,100	587,500
59	319,800	316,600	636,400
1959-60	321,000	352,700	673,700

watershed. Imported water from Owens Valley reached the San Fernando Valley in 1913. In the early 1920's, it became apparent that even this supply would be inadequate to meet expected future requirements and studies were initiated by the City of Los Angeles leading to the importation of Colorado River water through the Colorado River Aqueduct. This aqueduct was constructed by The Metropolitan Water District of Southern California, and importations began in 1941. Seasonal quantities of import from these sources from 1929 to 1960 are presented in Table 3. Inspection of Table 3 shows that the Los Angeles Aqueduct has been operating essentially at capacity for many years. Importations through the Colorado River Aqueduct have increased quite rapidly during the last decade, increasing nearly sevenfold in that period. Total import to Los Angeles County amounted to about 674,000 acre-feet in 1960, an increase of about 43 percent over the amount imported during 1954-55, the period of the previous report on this area.

#### Sewage and Industrial Waste Disposal

Waste water effluents within the area of investigation are generally discharged to the ocean or disposed to cesspools or septic tanks, although recent action has been taken to reclaim a small portion of this water for ground water replenishment. For purposes of this investigation, it was assumed that waste water effluents discharged to the ocean were irrecoverably lost but that all other effluents were available for reuse.

Coastal Los Angeles County is served by two major sewage and waste disposal agencies. The City of Los Angeles operates two systems, one discharging effluent through the Hyperion Treatment Plant and Outfall

TABLE 4

HISTORICAL SEASONAL DISCHARGE OF SEWAGE AND INDUSTRIAL WASTE  
TO OCEAN FROM COASTAL LOS ANGELES COUNTY

In acre-feet

Season ending:	: City of Los Angeles		: County Sanitation:	
September 30 :	Hyperion	Terminal	: Districts of Los Angeles County	Total
	outfall	: Island	: joint outfall	
1929-30	126,500	3,300	10,900	140,700
31	126,700	3,100	12,900	142,700
32	128,100	2,800	14,700	145,600
33	124,700	2,900	15,300	142,900
34	112,000	2,900	16,300	131,200
1934-35	127,100	3,000	18,400	148,500
36	130,800	3,300	20,800	154,900
37	143,900	3,400	21,200	168,500
38	147,000	3,000	26,300	176,300
39	146,600	3,400	27,800	177,800
1939-40	150,500	3,300	31,300	185,100
41	167,500	3,900	36,600	208,000
42	160,000	4,200	38,800	203,000
43	162,500	5,600	49,400	217,500
44	187,400	6,500	56,700	250,600
1944-45	178,700	6,600	57,300	242,600
46	179,400	6,700	60,600	246,700
47	204,600	7,000	66,200	277,800
48	218,300	6,200	87,500	312,000
49	223,200	6,600	115,000	344,800
1949-50	213,500	6,300	126,800	346,600
51	230,200	5,800	139,000	375,000
52	255,900	6,200	161,900	424,000
53	258,600	5,900	169,100	433,600
54	271,300	6,600	190,900	468,800
1954-55	273,500	6,900	198,700	479,100
56	281,500	6,700	204,600	492,800
57	290,000	7,000	217,500	514,500
58	299,500	7,000	249,300	555,800
59	292,500	6,900	270,100	569,500
1959-60	291,700	7,200	291,300	590,200

near Manhattan Beach, and a second disposing through a treatment plant located on Terminal Island. The second major agency is the County Sanitation Districts of Los Angeles County which treats the collected waste water and discharges it through an outfall located near Whites Point just west of San Pedro.

The total volume of sewage and industrial waste discharged to the ocean from Coastal Los Angeles County during 1959-60, was about 590,200 acre-feet, a 23 percent increase during the five-year period since 1954-55. Presented in Table 4 is a tabulation of quantities of sewage and industrial waste discharged to the ocean from the three treatment plants serving Coastal Los Angeles County.

## CHAPTER II. LAND USE

The type, location, and areal extent of present land use within Coastal Los Angeles County was determined by a detailed land use survey conducted during the summer of 1960. The results of that survey are presented in this chapter along with a discussion of methods and procedures, and tabulations of land use within the various hydrologic units and other appropriate subdivisions of the investigational area. This chapter also presents comparisons of land uses found during the present survey with those determined in 1955.

### Methods and Procedures

In order to relate present land use data to historical data, survey procedures similar to those of previous surveys were employed. Mapping of Coastal Los Angeles County was initiated in July 1960, by department field crews. Most of the area was mapped on 1960 vertical aerial photos, except for some scattered areas in the foothill regions of the San Gabriel Mountains where photos were supplemented by United States Geological Survey quadrangle maps. In the office appropriate political and hydrological boundaries, which are listed in Appendix D, were delineated on United States Geological Survey quadrangles of a scale 1 inch equal to 2,000 feet. These quadrangles provided area control to insure accuracy of succeeding processes. The quadrangles were enlarged to photo scale (1 inch equal to 1,000 feet) from which the quadrangle area and boundaries were transferred to acetate. The land use on the completed photos was then transferred by projection to the prepared acetate sheets which, upon completion, were reproduced as an ozalid print. Land uses within the various

boundaries were cut from the ozalid print and weighed. The acreage of all land use types were computed, utilizing an electronic computer, by relating their weights to the weight of a known quadrangle area. Because of the control developed by the use of quadrangles, the overall acreage results can be considered accurate to within about plus or minus three percent. However, the results for individual acreages should not be considered to have an accuracy of more than plus or minus five percent.

For purposes of critical hydrologic analysis it would be desirable to determine and compile the types of land use, either developed or undeveloped, for the entire area of a hydrologic unit, permitting a comprehensive analysis and evaluation of the various levels of water use for the entire area. However, a complete compilation is time-consuming and expensive and it is the usual practice to map only those types of land use requiring applied water in areas which are not underlain by water-bearing materials. All other types of land use in areas not underlain by water-bearing materials are mapped as "unclassified."

#### Classification of Land Use

For purposes of analysis and presentation, the various land uses were grouped into two major categories under Water Service Areas: Urban and Suburban, and Irrigated Agriculture; and into three major categories under Nonwater Service Areas: Nonirrigated Agriculture, Native Vegetation, and Unclassified. The major categories under water service areas each include several classes of land use, and these several classes consist of various types of land use. The objective of this classification procedure was to group the various types of land use into classes, each of which were considered to require similar amounts of water.

The water service and nonwater service areas, major categories, specific classes, and types of land use included in the classification are as follows:

WATER SERVICE AREA

Urban and Suburban Category

<u>Class of Land Use</u>	<u>Type of Land Use</u>
Residential . . . . .	Single and multiple family houses and apartments, farmsteads, trailer parks, recreational residential, institutions, motels, one- and two-story hotels, and residential subdivisions under construction at time of survey.
Commercial . . . . .	Commercial enterprises, including strip commercial and downtown type commercial areas, but excluding one- and two-story hotels, motels and institutions.
Industrial . . . . .	All classes of industrial land use involving manufacturing, processing, packaging, and storage operations, but excluding extractive industries (oil, sand, and gravel).
Unsegregated urban and suburban area . . . . .	Schools, dairies, livestock ranches, parks, cemeteries, and golf courses.
Included nonwater service area . . . . .	Extractive industries (oil, sand, and gravel), vacant lots, railroads, streets, freeways, and other miscellaneous paved areas.

### Irrigated Agriculture Category

<u>Class of Land Use</u>	<u>Type of Land Use</u>
Alfalfa . . . . .	Alfalfa raised for hay, seed, or pasture.
Pasture . . . . .	Irrigated grasses and legumes other than alfalfa used for livestock forage.
Citrus and subtropical . . . . .	Oranges, lemons, grapefruit, avocados, and olives.
Truck crops . . . . .	Vegetables of all varieties, including all categories of beans, flowers and other nursery crops.
Field crops . . . . .	Corn, sugar beets, and grain sorghums.
Deciduous fruits and nuts . . . . .	All varieties of deciduous fruits and nuts, including walnuts.
Small grains . . . . .	Barley, wheat, oats, and mixed hay and grain.
Vineyards . . . . .	All varieties of grapes.
Fallow . . . . .	Tilled, between crops.
Included nonwater service area . . . . .	Highways and roads, farm access roads, and other inclusions not devoted to crop production, including idle and abandoned lands.

### NONWATER SERVICE AREA

	<u>Type of Land Use</u>
Nonirrigated Agriculture Category . . . . .	All nonirrigated agriculture overlying defined ground water basins.

<u>Native Vegetation Category</u>	Native grasses, brush, and trees, including phreatophytes, overlying defined ground water basins.
<u>Unclassified Category</u>	Bare ground, including river washes, beaches, and water surface overlying defined ground water basins. It also includes nonirrigated agriculture and native vegetation not overlying defined ground water basins.

The classes of land use given here are similar to those used in Bulletin No. 24, except for the following changes: one- and two-story hotels and motels, formerly classified as "Commercial," have been placed under the "Residential" category; parks, golf courses, and cemeteries have been transferred from the "Irrigated pasture" category to "Unsegregated urban and suburban area"; walnuts have been included under "Deciduous fruits and nuts," and olives have been transferred from "Deciduous fruits and nuts" to "Citrus and subtropical." The "Field crops" category was formerly called "Unclassified crops," and "Fallow," now listed separately, was included with "Nonirrigated Agriculture" in Bulletin No. 24.

Delineation of urban and agricultural lands in the field was accomplished on the basis of gross areas, including nonwater-using lands such as streets, alleys, powerline rights-of-way, and other essentially nonwater-using lands. These nonwater-using types of land use were extracted from gross land use totals by applying the appropriate reduction factor listed in Table 5 to the gross area of each major land use class. The resulting product was added to the acreage classified as "Included nonwater service area."

TABLE 5

## FACTORS FOR REDUCTION OF GROSS AREAS TO NET WATER SERVICE AREAS IN COASTAL LOS ANGELES COUNTY

Land use	:	Percent deducted from gross area
Residential		20
Residential rural		15
Commercial		30
Industrial manufacturing		25
Schools		15
Lawn areas		15
Dairies		10
Farmsteads		5
Irrigated agriculture		5

During this investigation the factors used in Bulletin No. 24 to reduce gross areas to net water service areas, particularly the factors for urban land use classes, were reviewed to determine if they were still valid. As a result of the review it was found that the factor for single residential averaged 19.9 percent while multiple residential averaged 20.3 percent, and a value of 20 percent was used as the reduction factor for the residential category of land use. This compares to a value of 25 percent used in connection with the survey for Bulletin No. 24.

In a similar manner, a factor of 30 percent was adopted in this report for both downtown and strip commercial type land uses, as compared to a value of 35 percent which was used in Bulletin No. 24. The review of

factors for other types of land use indicated that in general the Bulletin No. 24 values remain valid.

#### Results of Land Use Survey

Data derived from this land use survey are compiled in Table 6 according to hydrologic units. In Appendix C these data are listed according to the hydrologic subunits delineated on Plate 2. These tables reveal that 610,520 acres of land in Coastal Los Angeles County required water service in 1960. Of this total, 564,990 acres or over 92 percent were in the urban and suburban category and 45,530 acres were in irrigated agriculture.

Detailed information concerning the pattern of land use in the survey area is given on Plates 5A, 5B, 5C, 5D, and 5E, "Present Land Use." Although the acreages of nonwater service areas within urban and suburban and agricultural areas are shown individually on the summary tables in this chapter and in Appendix C, they were not differentiated on the plates. Also not differentiated on these plates were developed nonwater service lands, such as nonirrigated agriculture and undeveloped nonwater service lands, such as native vegetation.

A tabulation of land use as observed within the boundaries of several major water agencies is presented in Table 7. Approximately 598,750 acres, or 98 percent of the entire gross water service area within the investigation, are located in these districts. Land use listed in The Metropolitan Water District of Southern California includes the acreages of member districts also listed in Table 7. These include the Central Basin

TABLE 6  
1960 LAND USE IN COASTAL LOS ANGELES COUNTY  
BY 1960 HYDROLOGIC UNITS

Category and class of land use	In acres	Hydrologic Units						Totals
		Los Angeles : Coastal Plain:	San Fernando :	San Gabriel :	Upper Santa : Ana Valley :	Malibu	Orange County : Coastal Plain:	
<u>WATER SERVICE AREA</u>								
Urban and Suburban								
Residential	143,330	62,780	54,600	5,660	1,720	110	268,200	
Commercial	16,530	4,010	3,360	4,80	80	0	24,460	
Industrial	21,640	3,180	2,370	370	*	10	27,570	
Unsegregated urban and suburban area	<u>21,030</u>	<u>6,820</u>	<u>6,620</u>	<u>290</u>	<u>170</u>	<u>—</u>	<u>35,620</u>	
Subtotals	202,530	76,820	66,950	7,460	1,970	120	355,850	
Included Nonwater-Service Area	<u>115,770</u>	<u>47,300</u>	<u>35,270</u>	<u>5,760</u>	<u>1,980</u>	<u>60</u>	<u>209,140</u>	
Gross Urban and Suburban Area	318,300	124,120	102,220	13,220	6,950	180	564,990	
<u>Irrigated Agriculture</u>								
Alfalfa	570	750	250	20	60	0	1,650	
Pasture	1,400	860	1,320	140	0	50	3,770	
Citrus and subtropical	2,220	5,130	8,600	2,830	*	750	19,530	
Truck crops	<u>5,770</u>	<u>1,560</u>	<u>1,620</u>	<u>170</u>	<u>100</u>	<u>10</u>	<u>9,230</u>	
Field crops	660	430	230	60	0	0	1,380	
Deciduous fruits and nuts	50	540	730	260	10	0	1,590	
Small grains	210	90	130	100	60	0	590	
Vineyards	0	60	—	*	0	0	60	
Subtotals	10,880	9,420	12,880	3,580	—	—	37,800	
Fallow	2,010	1,080	320	0	20	0	3,430	
Included Nonwater-Service Area	<u>820</u>	<u>910</u>	<u>1,840</u>	<u>640</u>	<u>10</u>	<u>80</u>	<u>4,300</u>	
Gross Irrigated Agriculture	<u>13,710</u>	<u>11,410</u>	<u>15,040</u>	<u>4,220</u>	<u>260</u>	<u>890</u>	<u>45,530</u>	
GROSS WATER SERVICE AREA	332,010	135,530	117,260	17,440	7,210	1,070	610,520	
<u>NONWATER-SERVICE AREA</u>								
Nonirrigated Agriculture	9,420	2,030	7,660	1,580	660	40	21,390	
Native Vegetation	9,250	21,860	13,630	2,810	3,930	1,090	52,570	
Unclassified	<u>41,590</u>	<u>163,370</u>	<u>239,400</u>	<u>16,500</u>	<u>88,390</u>	<u>9,460</u>	<u>519,710</u>	
GROSS NONWATER-SERVICE AREA	<u>60,260</u>	<u>187,260</u>	<u>251,690</u>	<u>20,890</u>	<u>92,980</u>	<u>10,290</u>	<u>623,670</u>	
TOTALS	392,270	322,790	368,950	38,330	100,190	11,660	1,234,190	

\*Less than five acres.

TABLE 7

## 1960 LAND USE IN SERVICE AREAS OF MAJOR WATER AGENCIES IN COASTAL LOS ANGELES COUNTY

In acres

Category and class of land use	Metropolitan:	Central :	Pomona Valley :	San Gabriel:	West Basin :
	Water :	Basin :	Las Virgenes :	Upper : Municipal	Upper : Municipal
	District of:	Municipal :	Municipal :	San Gabriel : Water	San Gabriel : Water
	Southern :	Water :	Water :	District :	District :
	California :	District :	District :	District :	District :
<u>WATER SERVICE AREA</u>					
<u>Urban and Suburban</u>					
Residential	227,190	42,550	6,480	9,610	26,590
Water	21,640	3,800	180	630	1,920
Commercial	12,710	4,250	30	250	730
Industrial	<u>30,720</u>	<u>9,710</u>	<u>360</u>	<u>1,970</u>	<u>610</u>
Unsegregated urban and suburban area					
Subtotals	292,260	60,310	7,050	12,460	7,780
Included Nonwater Service Area	<u>192,160</u>	<u>38,910</u>	<u>2,510</u>	<u>1,520</u>	<u>4,570</u>
Gross Urban and Suburban Area	484,420	99,220	9,560	2,610	12,350
Irrigated Agriculture					
<u>Alfalfa</u>					
Pasture	1,370	540	0	50	0
3,070	1,330	0	840	0	210
Citrus and subtropical	16,890	2,920	80	8,770	110
8,180	1,140	30	690	30	670
Truck crops	1,200	430	0	110	0
Field crops	210	30	0	20	0
Deciduous fruits and nuts	0	0	0	0	0
Small grains	0	0	0	0	0
Vineyards	<u>70</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>
Subtotals	30,990	6,390	110	70	10,480
Pallow	3,160	680	0	30	<sup>b</sup>
Included Nonwater Service Area	<u>3,620</u>	<u>570</u>	<u>10</u>	<u>1,860</u>	<u>10</u>
Gross Irrigated Agriculture	<u>37,770</u>	<u>7,640</u>	<u>120</u>	<u>100</u>	<u>150</u>
GROSS WATER SERVICE AREA	522,190	106,860	9,680	2,710	34,530
NONWATER SERVICE AREA					
<u>Nonirrigated Agriculture</u>					
Native Vegetation	17,600	2,200	10	660	6,720
29,000	3,380	1,320	3,560	7,560	1,560
148,080	<u>2,250</u>	<u>2,820</u>	<u>69,220</u>	<u>37,220</u>	<u>1,210</u>
Unclassified					
GROSS NONWATER SERVICE AREA	194,680	<u>10,830</u>	<u>4,150</u>	<u>74,140</u>	<u>51,500</u>
TOTALS	716,870	117,690	13,830	76,850	86,030
				15,280	86,000
					106,790

a. Upper San Gabriel Valley Municipal Water District.  
 b. Less than five acres.

Municipal Water District, Foothill Municipal Water District, Pomona Valley Municipal Water District, and West Basin Municipal Water District.

A projection of urban and suburban acreage requirements in the year 2020 was made in connection with the preparation of Bulletin No. 78, "Investigation of Alternative Aqueduct Systems to Serve Southern California." In that report the gross urban and suburban areas were estimated to be about 996,000 acres by the year 2020, and it was forecast that there will be no irrigated agriculture in Coastal Los Angeles County by that date. The 1960 land use requiring water service was about 61 percent of the forecast 2020 value.

#### Change in Land Use

Recent changes in land use in the area of investigation are indicated by the data presented in Table 8. This table lists the acreages of the various classes of land use determined from surveys made in 1955 and 1960. In order to make a valid comparison of land use between the two dates, it was necessary to exclude the development in the San Gabriel Mountains from the 1960 land use. The comparisons that follow are based on the same area as shown on Plates 6A and 6B entitled "Change in Land Use, 1955 to 1960," and correspond to the Bulletin No. 24 investigational area.

During the five-year period 1955 to 1960, the gross water service area increased from 550,900 acres to 609,600 acres, a gain of approximately 11 percent. There was a continued encroachment of urban and suburban growth on agricultural lands resulting in a loss of 48,500 acres or 51 percent reduction of the 1955 agricultural area. Most of this decline

TABLE 8

COMPARISON OF 1955 AND 1960  
LAND USE IN COASTAL LOS ANGELES COUNTY  
BY 1955 HYDROLOGIC UNITS

In acres

Category and class of land use	Hydrologic Units			Santa Ana <sup>b</sup>	Malibu	Totals
	Coastal Plain <sup>a</sup>	San Fernando	San Gabriel			
1955 : 1960	1955 : 1960	1955 : 1960	1955 : 1960	1955 : 1960	1955 : 1960	1955 : 1960
<b>WATER SERVICE AREA</b>						
Urban and Suburban						
Residential	137,600	147,100	58,700	48,200	55,800	3,200
Commercial	14,600	16,800	4,500	3,200	3,400	400
Industrial	19,600	21,800	2,500	3,200	2,500	100
Unsegregated urban and suburban area	10,200	21,500	1,800	3,200	6,900	400
Subtotals	182,000	207,200	57,200	71,800	55,600	4,100
Included Nonwater-Service Area	101,300	119,200	21,300	44,000	28,400	3,500
Gross Urban and Suburban Area	283,300	326,400	78,500	115,800	84,000	10,300
<b>Irrigated Agriculture</b>						
Alfalfa	800	600	3,400	800	1,000	300
Pasture	11,300	1,500	5,100	900	3,400	1,400
Citrus and subtropical	4,800	3,000	7,500	5,100	15,400	8,800
Truck crops	8,600	5,800	4,200	1,600	4,200	1,700
Field crops	1,400	700	800	400	700	300
Deciduous fruits and nuts	400	100	2,300	500	1,600	900
Small grains	200	200	400	100	200	200
Vineyards	d	0	d	100	d	c
Subtotals	27,500	11,900	23,700	9,500	26,500	13,600
Fallow	4,900	2,000	e	1,100	1,800	300
Included Nonwater-Service Area	1,500	900	1,100	900	1,300	1,900
Gross Irrigated Agriculture	33,900	14,800	24,800	11,500	29,600	15,800
GROSS WATER SERVICE AREA	317,200	341,200	103,300	127,300	113,600	120,900
<b>NONWATER-SERVICE AREA</b>						
NonIrrigated Agriculture	16,400	9,500	1,900	2,000	14,500	8,400
Native Vegetation	87,600	97,100	15,700	41,600	14,300	8,800
Unclassified	3,600	63,500	1,500	28,800	10,700	26,800
GROSS NONWATER-SERVICE AREA	107,600	83,600	100,500	76,500	66,100	59,500
TOTALS	424,800	424,800	203,800	203,800	180,400	180,400

- a. Los Angeles Coastal Plain includes Orange County  
    Coastal Plain Unit.  
b. Upper Santa Ana Valley.
- c. Less than 50 acres.  
d. Vineyards in 1955 survey included in unclassified crops.  
e. Value not available.



San Fernando Valley  
Urban encroachment on agricultural lands  
1954 (upper)—1960 (lower)

Spence Air Photos



Spence Air Photos

occurred in pasture, citrus, and truck crop lands. The historical increases of urban and suburban lands along with the growth and decline of agriculture are shown graphically on Plate 3. The area of vacant habitable land indicated on the plate was determined from land classification surveys conducted for Bulletin No. 2.

#### Los Angeles Coastal Plain Unit

The water service area in the Los Angeles Coastal Plain Unit increased by 24,000 acres or 8 percent between 1955 and 1960, and this growth closely paralleled the percent change in land use between the years 1950 and 1955. Urban and suburban areas increased by 15 percent, gaining 43,100 acres, to bring the total up to 326,400 acres. The new development occurred throughout the coastal plain, but most noticeable areas of growth have been in the vicinities of Torrance, southwest Los Angeles and the Santa Monica Mountains. The area in irrigated agriculture dropped 56 percent with a loss of 19,100 acres, over half of it pasture, which resulted in the reduced 1960 irrigated acreage of 14,800 acres.

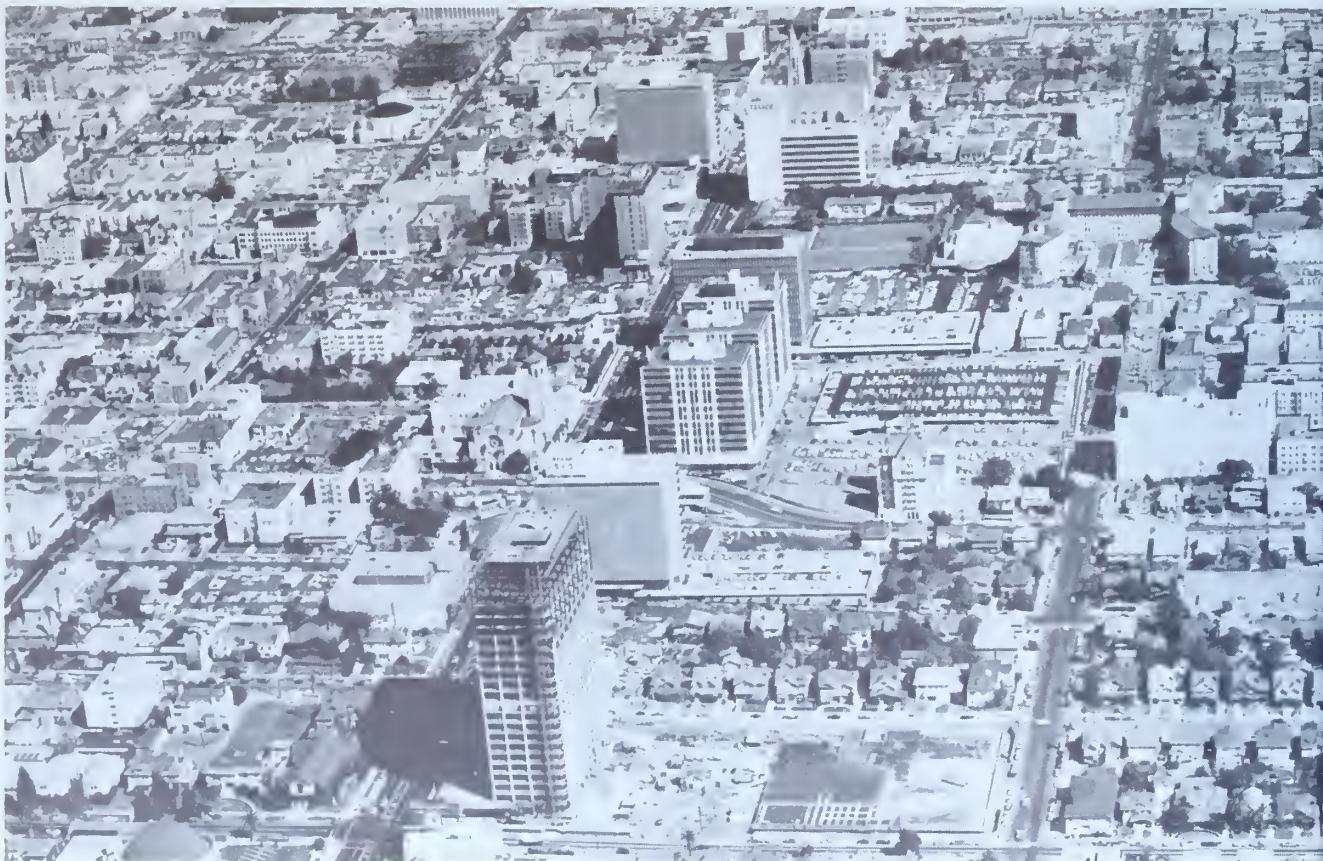
#### San Fernando Unit

The San Fernando Unit experienced a net increase of about 24,000 acres in gross water service area between 1955 and 1960. While urban and suburban lands in the unit increased about 37,300 acres or almost 48 percent, there was a corresponding decrease in irrigated lands of 13,300 acres or about 54 percent. The growth in urban and suburban lands was primarily the result of residential development. The indicated decrease of the commercial type of land use in the summary tables is the result of the classification change previously noted. There was a reduction in the



Wilshire Boulevard  
Commercial land use changes  
1955 (upper)—1960 (lower)

Spence Air Photos



Spence Air Photos

acreage of all agricultural crops but the greatest reduction was experienced by truck crops, alfalfa, and pasture. From inspection of Plate 6A it can be seen that the increase in urban and suburban land uses occurred primarily in the western part of the unit between the City of San Fernando and the Calabasas area.

#### San Gabriel Unit

Urban and suburban development increased 21,100 acres or about 25 percent since 1955 with agriculture decreasing about 47 percent, from 29,600 acres to 15,800 acres. A large part of the urban growth occurred as the result of residential development in the central part of the unit around Baldwin Park, Covina and the foothill areas of the mountains. The acreage increase in urban and suburban development and decrease in irrigated agricultural use closely follows the amounts gained and lost between 1950 and 1955, which indicates a constant rate of change within San Gabriel Valley. There was a substantial decline in acreage planted to citrus.

#### Upper Santa Ana Valley Unit

The Upper Santa Ana Valley Unit water service area was increased by 600 acres between 1955 and 1960, with irrigated agriculture decreasing from 5,500 acres to 3,500 acres, or about 36 percent. During the same period urban and suburban land use increased about 34 percent, with an acreage increase from 7,700 acres in 1955 to 10,300 in 1960 primarily as a result of residential development.

#### Malibu Unit

The Malibu Unit experienced an increase in water service area of 2,800 acres or almost 78 percent between the years 1955 and 1960. Urban

and suburban land use increased 103 percent with new development amounting to 3,100 acres being constructed during the five-year period. Rough topography and few roads have limited growth to accessible areas such as Point Dume and along Topanga Canyon. Irrigated agriculture decreased from 600 to 300 acres.

### CHAPTER III. WATER USE

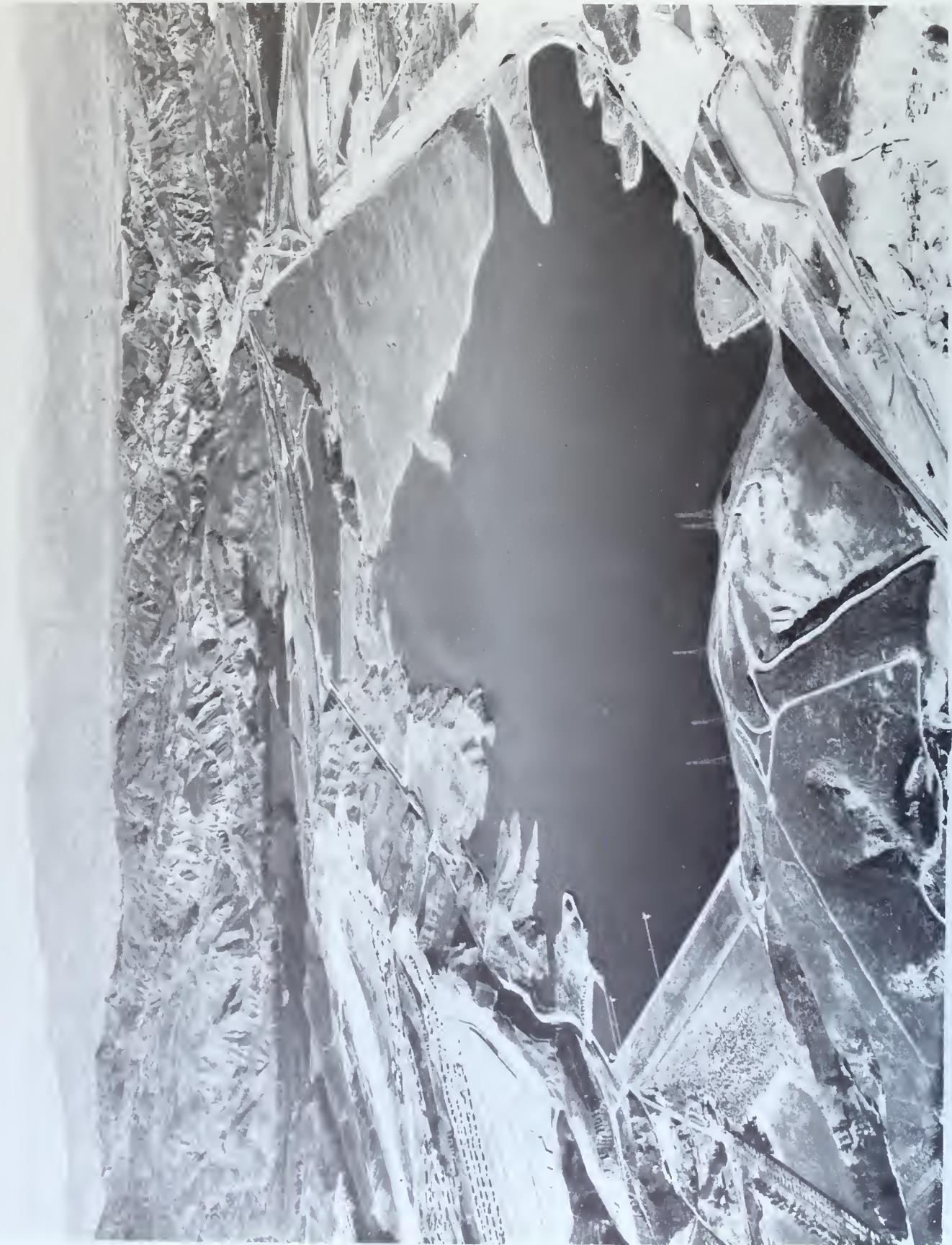
The land areas occupied by various types of water-using developments described in Chapter II, and appropriate unit values of water use were employed to estimate the 1960 quantities of water use in the investigational area. This chapter presents the estimates of water use and the change in water use since previous estimates were made. A discussion of the relationships between estimated water use and available supplies is also presented.

#### Definition of Water Use

The term "water use" is employed in the broadest sense to include all uses of water by nature under native conditions and by man-made modifications of those natural conditions. It implies the application of water to any one, or all, of innumerable kinds of uses, both consumptive and nonconsumptive.

Consumptive use includes the water from any source utilized in the process of vegetative growth, such as transpiration and the building of plant tissue, and the water evaporated from the soil around the plant and foliage, as well as from water surfaces. It also includes the water consumed or evaporated by urban and nonvegetative types of land use.

In addition to the consumptive use of water as defined above there may be irrecoverable losses incidental to such use. These irrecoverable losses include such items as deterioration in water quality to the point where the water is unsuitable for reuse; disposal or seepage of the unconsumed water to bodies of unsuitable quality, including the ocean;



and disposal or seepage of the unconsumed water in such a manner as to be uneconomical of recapture for use.

The water for consumptive use is obtained from two general sources: natural sources including direct precipitation and surface runoff, and, as a special case, from a high ground water table; and man-developed sources, that is, water applied through the activities of man. Water furnished from this latter source is defined as "applied water."

Man applies water to satisfy the consumptive-use needs in excess of that supplied from natural sources. However, as a practical matter, the quantity of water applied is usually in excess of the consumptive use of applied water; consequently, that portion of the water applied to any use that is not consumed or irrecoverably lost remains part of the water supply.

In evaluating the overall needs for water in an area, it is necessary to determine the portion of the applied water that is consumptively used. That portion of the applied water that is consumptively used and irrecoverably lost is known as the "net water use," and the difference between the applied water and the net water use is the amount of applied water that is subject to reuse as a part of the common supply.

#### Methods of Estimating Water Use

It follows from the previous discussion that in areas where none of the applied water becomes available for reuse, it is possible to determine the net water use by measuring the total water applied. On the other hand, in areas where a portion of the applied water becomes available for reuse, present technology is generally inadequate to measure this

volume of return flow of reusable water. The net water use in these areas must be determined in another manner; therefore, an indirect method is used.

Using the indirect method commonly employed, estimates of net water use are obtained by multiplying the areas of the various classes of water using developments by appropriate average values of unit water use. To the product of this multiplication must be added all water disposal, such as sewage to the ocean or seepage to points where the water is unsuitable for reuse.

The unit values of water use reflect average conditions of precipitation and the normal practices associated with urban water distribution and with irrigated agriculture. Variations from normal or average in these factors during the specific year that a land use survey is conducted, may result in a difference between the estimated and actual water use during that year. Despite this possibility, it is considered that the procedures used in this survey are adequate, and that the figures on current levels of water use are reasonable. Furthermore, it is believed that these estimates of net water use are sufficiently sound to permit their use in determining the adequacy of presently available water supplies and for planning for such additional supplies as will be necessary to meet current or expected future deficiencies.

#### Unit Values of Water Use

Mean seasonal unit values of water use derived for Bulletin No. 2 and also used in Bulletin No. 24 were reviewed to determine their applicability to present conditions. The results of this review indicate that,

in general, mean seasonal values derived for Bulletin No. 2 are still the best available. A complete discussion of the techniques employed in the derivation of the values is contained in Bulletin No. 2, and is supplemented in Bulletin No. 2<sup>4</sup>, therefore, only a general description of these procedures is contained herein.

#### Unit Values of Water Use on Urban and Suburban Lands

Mean seasonal unit values of consumptive use of water on urban and suburban lands were derived from (1) estimates of the consumptive use on the area occupied by impervious cover, bare lands, lawns, shrubs, etc. and (2) estimates of other urban consumptive uses such as internal household uses. The mean seasonal unit values of consumptive use of water so determined are presented in Table 9.

TABLE 9

#### ESTIMATED MEAN SEASONAL UNIT VALUES OF CONSUMPTIVE USE OF WATER ON URBAN AND SUBURBAN LANDS IN COASTAL LOS ANGELES COUNTY

In feet of depth per unit of area

Land use classification	Consumptive use		
	: Applied	: Precipi-	: Total
	: water	: tation	:
Residential, single	1.3	0.9	2.2
Residential, multiple	0.3	0.6	0.9
Residential, rural	0.8	0.8	1.6
Commercial, strip	0.4	0.5	0.9
Commercial, downtown	1.1	0.5	1.6
Industrial, manufacturing	1.4	0.6	2.0
Schools	0.4	0.7	1.1
Dairies	1.0	0.9	1.9
Livestock and poultry ranches	0.6	0.7	1.3
Industrial extractive	--	0.6	0.6
Vacant	--	0.6	0.6
Streets and roads	--	0.5	0.5

### Unit Values of Water Use on Irrigated Agriculture

Mean seasonal values of consumptive use of water for irrigated crops were derived by a modification of a method developed by Harry F. Blaney and Wayne D. Criddle of the United States Department of Agriculture. These values are presented in Table 10.

The values shown in Table 10 represent estimates of the average consumptive use of applied water and precipitation by the various types of irrigated agriculture for the area defined. In the derivation of the net water use for any given year the volume of applied water required is based on the assumption that the precipitation for the season was approximately equal to the long-time mean. However, the use of applied water will actually be somewhat larger or smaller in individual years varying inversely with the amount of rainfall. A similar effect occurs in the instance of urban use, however, the use of precipitation by residential, commercial, and industrial classifications is small. Therefore, variations of rainfall from year to year have a lesser effect upon the use of applied water on these lands than on irrigated lands. Variations from average conditions can also occur within hydrologic units to the extent that topography and other physical or cultural features can affect climate and rainfall, so the net water use and use of applied water may differ to a considerable extent from small localized area to small localized area within the unit.

### Net Water Use

Estimates of the amount of net water use in Coastal Los Angeles County under 1960 conditions of development and under normal precipitation conditions are presented in this section. As previously indicated, net water use was estimated by applying mean seasonal unit values of water use

TABLE 10

ESTIMATED MEAN SEASONAL UNIT VALUES OF CONSUMPTIVE  
USE OF WATER ON IRRIGATED LANDS IN  
COASTAL LOS ANGELES COUNTY

In feet of depth per unit of area

Type of land use:	Hydrologic units										Orange County Coastal Plain
	Los Angeles Coastal Plain	San Fernando	San Gabriel	Upper Santa Ana Valley	Malibu	Total	Applied:Precip=:	Applied:Precip=:	Total	Applied:Precip=:	
	:Applied:Precip=:	Total	:Applied:Precip=:	Total	:Applied:Precip=:	Total	:Applied:Precip=:	Total	:Applied:Precip=:	Total	:Applied:Precip=:
	: water :irration:	water :irration:	: water :irration:	: water :irration:	: water :irration:	: water :irration:	: water :irration:	: water :irration:	: water :irration:	: water :irration:	: water :irration:
Alfalfa	2.4	1.1	3.5	2.3	1.4	3.7	2.3	1.4	3.7	2.0	1.3
Pasture	2.4	1.1	3.5	2.5	1.2	3.7	2.4	1.3	3.7	2.2	1.1
Citrus and sub-tropical	1.3	1.1	2.4	1.5	1.1	2.6	1.4	1.2	2.6	1.2	1.1
Truck crops	1.3	0.9	2.2	1.2	0.9	2.1	1.2	0.9	2.1	1.0	1.1
Field crops	1.3	0.9	2.2	1.2	0.9	2.1	1.2	0.9	2.1	1.0	1.1
Deciduous	1.7	1.0	2.7	1.5	1.3	2.8	1.4	1.4	2.8	1.4	1.3
Walnuts	1.8	1.1	2.9	1.7	1.2	2.9	1.6	1.3	2.9	1.7	1.1
Small grain	0.7	0.9	1.6	0.7	1.0	1.7	0.7	1.0	1.7	0.6	1.0
Vineyards	1.3	0.9	2.2	1.2	0.9	2.1	1.2	0.9	2.1	1.0	1.1

to the net areas of each type of land use. In estimating the net water use in this manner it was assumed that all applied water in excess of consumptive use requirements, except the sewage and industrial waste exported from the area, returns to ground water storage and is available for reuse.

In regard to the foregoing method for determining net water use recent studies published in Appendix B of Bulletin No. 10<sup>4</sup> indicate that percolation occurs at slow rates in the confined ground water basins of the Los Angeles Coastal Plain Hydrologic Unit. In addition, available information suggests that similar conditions may occur in confined ground water basins of the Malibu Hydrologic Unit. As a result, the method of determining net water use described in the previous paragraph was considered applicable. This is at variance with techniques utilized in connection with the preparation of Bulletin No. 2<sup>4</sup> where net water use for the confined ground water areas was determined as the total applied water, and all water in excess of consumptive use requirements was assumed to be irrecoverably lost.

The estimated amounts of net water use in Coastal Los Angeles County for 1960 conditions of development are presented in Table 11, together with comparisons with the 1955 values. The 1955 net water use values have been revised as described above, and in some cases differ from those published in Bulletin No. 24.

Portions of the San Gabriel Mountains were not included in the Bulletin No. 24 study, however, a valid comparison of net water use between the two years has been made because the net water use in the area excluded from the 1955 survey is very small. It was on the order of 1,500 acre-feet per season in 1960.

As indicated previously the unit values used to derive the net water use represent the optimum needs of the various types of water using developments for average conditions of rainfall and climate. The actual net water use determined for a specific year may differ from the estimated values derived herein because of variations from the mean precipitation, but the estimates presented show general level of water use. Rainfall in the City of Los Angeles during the season of 1959-60 was about 55 percent of the 50-year mean precipitation for the period 1897-98 through 1946-47 in comparison to 80 percent of the same mean recorded during the 1954-55 season. Therefore, the estimates of levels of net water use shown in Table 11 are probably somewhat lower than the actual water use. The estimated 1960 values may deviate more than the 1955 values but the difference between estimates for the two years shown is considered to represent a good estimate of the increase in water use.

The data presented in Table 11 indicate that changes in net water use generally reflect the changes in land use described in Chapter II.

TABLE 11

ESTIMATED LEVELS OF NET WATER USE IN COASTAL LOS ANGELES COUNTY FOR CONDITIONS OF DEVELOPMENT IN 1955 AND 1960

In acre-feet

Hydrologic unit	:	1955	:	1960	:	Difference
<u>Los Angeles Coastal Plain Unit</u>						
Irrigated lands		48,600		16,200		-32,400
Urban and suburban areas		<u>585,100</u>		<u>681,400</u>		<u>96,300</u>
Subtotals		633,700 <sup>b</sup>		697,600		63,900

ESTIMATED LEVELS OF NET WATER USE IN COASTAL LOS ANGELES  
COUNTY FOR CONDITIONS OF DEVELOPMENT IN 1955 AND 1960  
(continued)

In acre-feet

Hydrologic unit	:	1955	:	1960	:	Difference
<u>San Fernando Unit</u>						
Irrigated lands		42,200		15,000		-27,200
Urban and suburban areas		<u>115,600</u>		<u>164,900</u>		<u>49,300</u>
Subtotals		157,800		179,900		22,100
<u>San Gabriel Unit</u>						
Irrigated lands		40,300		19,200		-21,100
Urban and suburban areas		<u>103,100</u>		<u>152,000</u>		<u>48,900</u>
Subtotals		143,400		171,200		27,800
<u>Upper Santa Ana Valley Unit<sup>a</sup></u>						
Irrigated lands		7,800		5,400		- 2,400
Urban and suburban areas		<u>9,000</u>		<u>14,500</u>		<u>5,500</u>
Subtotals		16,800		19,900		3,100
<u>Malibu Unit</u>						
Irrigated lands		800		300		- 500
Urban and suburban areas		<u>2,200</u>		<u>2,700</u>		<u>500</u>
Subtotals		3,000		3,000		0
<u>Orange County Coastal Plain Unit</u>						
Irrigated lands		-- <sup>c</sup>		1,100		1,100
Urban and suburban areas		-- <sup>c</sup>		<u>200</u>		<u>200</u>
Subtotals		-- <sup>c</sup>		1,300		1,300
<u>Total Investigational Area</u>						
Irrigated lands		139,700		57,200		-82,500
Urban and suburban areas		<u>815,000</u>		<u>1,015,700</u>		<u>200,700</u>
TOTALS		954,700		1,072,900		118,200

- a. This unit was known as the Pomona Hydrologic Unit in 1955.  
b. Value includes net water use in Orange County Coastal Plain Unit.  
c. Value included in Los Angeles Coastal Plain Unit.

The estimated net water use for conditions of 1960 in Coastal Los Angeles County was about 1,072,900 acre-feet, which is about 118,200 acre-feet or approximately 12 percent greater than the 1955 estimate of 954,700 acre-feet. The largest percentage increase occurred in the San Gabriel and Upper Santa Ana Valley Hydrologic Units where net water use in each increased about 18 and 19 percent, respectively. The largest total gain in net water use occurred in the Los Angeles Coastal Plain Unit where water use increased about 63,900 acre-feet or about 10 percent between 1955 and 1960.

#### Comparison of Water Supply and Water Use

The net water use in Coastal Los Angeles County calculated from land use surveys conducted in 1955 and 1960 is shown in Table 12 together with the approximate safe yield of local supplies as derived in Chapter I. Also shown in Table 12 is a comparison of the excess of net water use over the approximate safe yield of local supplies and the volume of water imported. The forecast net water requirements for the year 2020, which were derived from studies for Bulletin No. 78, are also presented in Table 12.

The data presented in Table 12 indicate that the net water use exceeded the sum of the approximate seasonal safe yield of local supply and the import during both of the survey years, and that there was a decrease in deficiency between 1955 and 1960. One obvious reason for this decrease is the relationship between the increase in net water use between the survey years and the increase in the volume of water imported into the area. The very notable increase in the volume of imports between 1955 and 1960 reflects the efforts of local agencies to substitute the utilization of imported supplies for ground water extractions and the substantial program

TABLE 12

COMPARISON OF NET WATER USE AND WATER SUPPLY OF  
COASTAL LOS ANGELES COUNTY

In acre-feet

		Approximate:	Excess of :		
Date of survey	Net water use	safe yield of local water supplies	over approx-imate safe yield of local supply	Seasonal import	Indicated deficiency for season
1955	955,000	374,000	581,000	470,000	111,000
1960	1,073,000	374,000	699,000	674,000	25,000
Estimated					
2020	2,346,000*	374,000	1,975,000		

\*Net water requirement

of purchasing imported supplies for the replenishment of ground water storage.

A second factor in the indicated decrease illustrates the previously discussed difficulty involved in relating actual water use for specific years with net water use, which is a value developed for average years. The precipitation for each of the years indicated in Table 12 was below average but not equally so, as 1954-55 was an 80 percent season, while 1959-60 was 55 percent of normal.

The amount of applied water used, both local and imported, during any year is dependent upon the dryness of the year, and upon the degree to which optimum water requirements are met. It is apparent that for the years described in Table 12 an overdraft occurred, and that use exceeded the safe supply. However, for reasons cited, the deficiencies indicated above should not be considered a direct measure of this overdraft, nor should the difference in deficiencies between years be considered a satisfactory

quantitative measure of the change in the magnitude of the overdraft. The development of such information is beyond the scope of this investigation. However, it is apparent that even greater efforts must be made to utilize imported supplies, not only to overcome the present deficiency, but also to meet the forecast needs.



## CHAPTER IV. SUMMARY AND CONCLUSIONS

The results of the land and water use survey of Coastal Los Angeles County, and conclusions drawn from this study are summarized in this chapter.

### Summary

1. A total of 610,500 acres or about 49 percent of all lands within the surveyed area have been developed for urban and suburban or irrigated agricultural uses in 1960. This is an increase of about 11 percent over similar water using development that existed in 1955.

2. The gross urban and suburban area in 1960 was 565,000 acres, an increase of about 108,000 acres or 24 percent over that which existed in 1955. This increase was a direct result of an increase in population in Coastal Los Angeles County from an estimated 5,033,600 in 1955 to 5,958,800 in 1960. The presently developed gross urban and suburban area occupies about 57 percent of the 996,000 acres which are considered susceptible to this intensive type of development by the year 2020.

3. The gross irrigated agricultural area in 1960 was about 45,500 acres, a decrease of 52 percent from the 94,400 acres that existed in 1955, and it is forecast that this type of land use will disappear in this area by the year 2020.

4. The estimated 1960 mean seasonal level of net water use by these water using developments was about 1,072,900 acre-feet. This is an increase of about 118,200 acre-feet, or approximately 12 percent, over the 1955 estimated net water use level.

5. The net water use in Coastal Los Angeles County exceeded the approximate seasonal safe yield of local water supplies during the period from 1955 to 1960. This deficiency has been alleviated somewhat through the efforts of many local agencies to substitute local ground water extractions with imported supplies.

6. The seasonal volume of imported water to Coastal Los Angeles County increased from 470,000 acre-feet in 1955 to 674,000 acre-feet in 1960. This increase was used largely to meet the increased water use in the investigational area, but a substantial amount was also used for replenishment of ground water storage.

7. The estimated total seasonal water requirement for Coastal Los Angeles County by the year 2020 has been estimated to be on the order of 2,346,000 acre-feet. Of this requirement, approximately 1,975,000 acre-feet must be derived by importing supplies from outside the area of investigation.

#### Conclusions

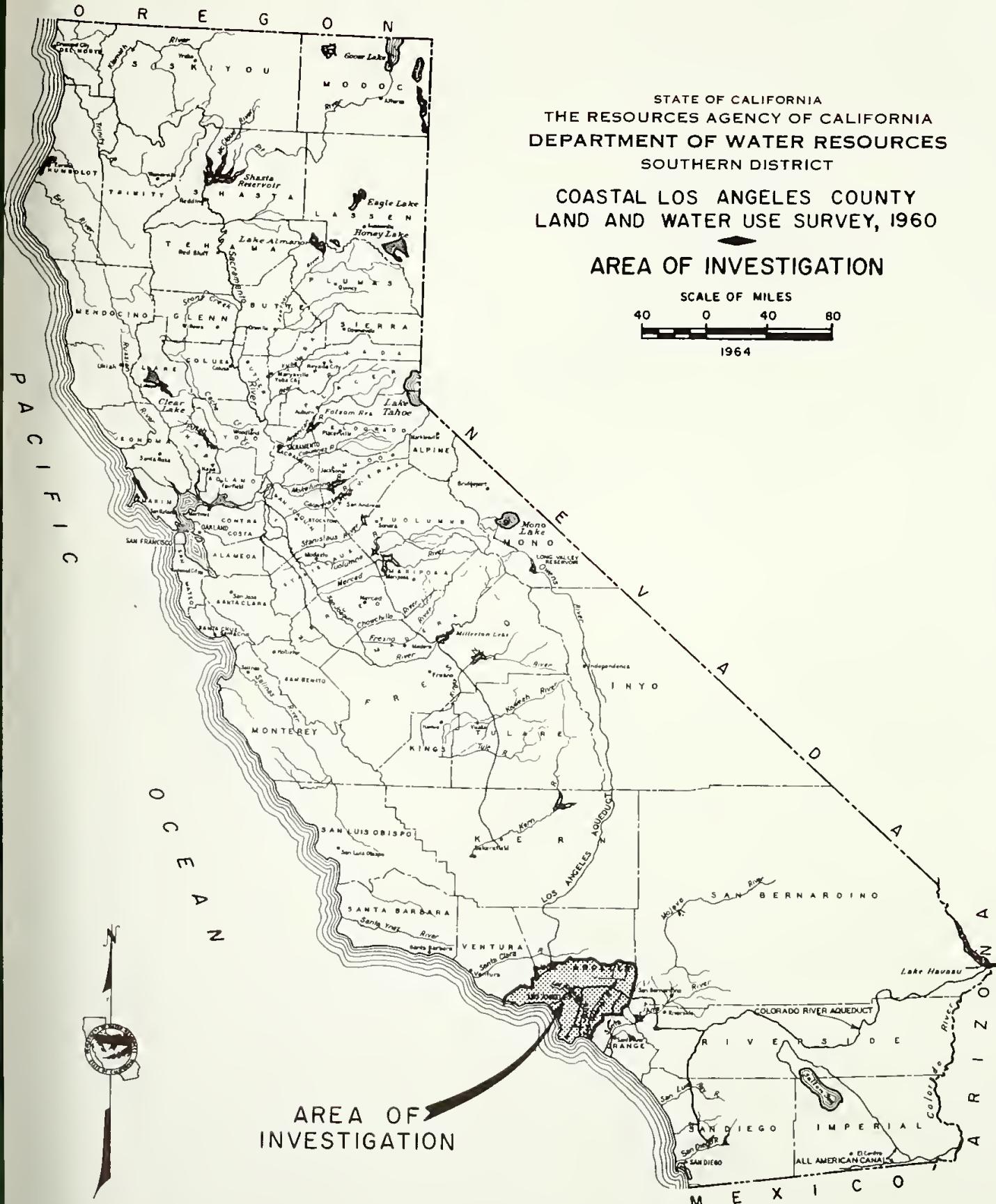
Based on the results of this investigation it is concluded that:

1. Economic and climatic factors have established a rapid rate of growth in population and industry in the area of investigation, and the growth will probably continue in the foreseeable future if adequate water supplies are available.

2. A large increase in the volume of water imported to the area will be required to meet the anticipated growth. This large volume of imported water can be made available only by a program of comprehensive planning and development of water resources.

3. The land uses, water requirements, and growth trends established by this study should be monitored and re-evaluated by future land use surveys in order that the water supplies required to support such growth can be adequately planned and developed.

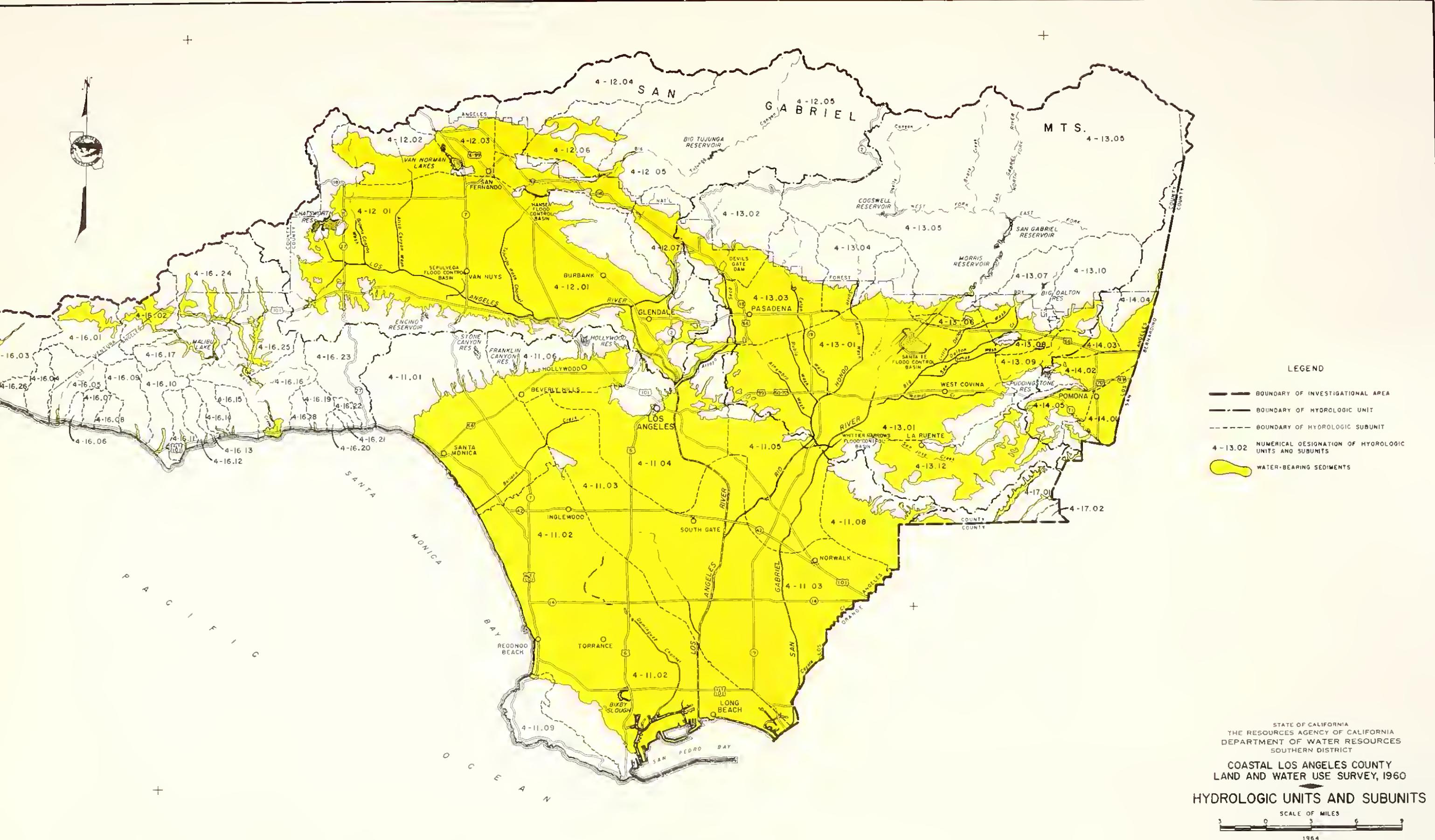




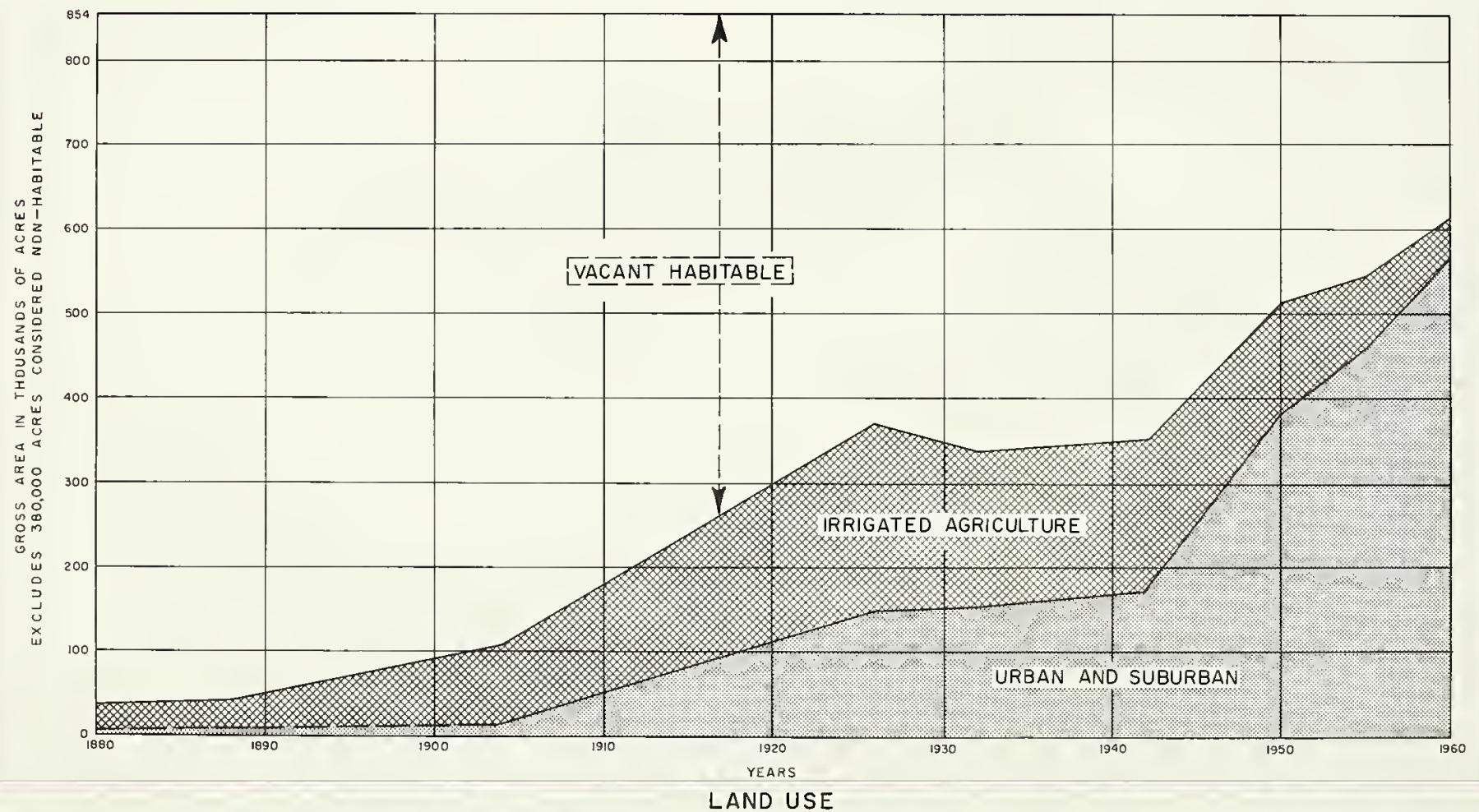
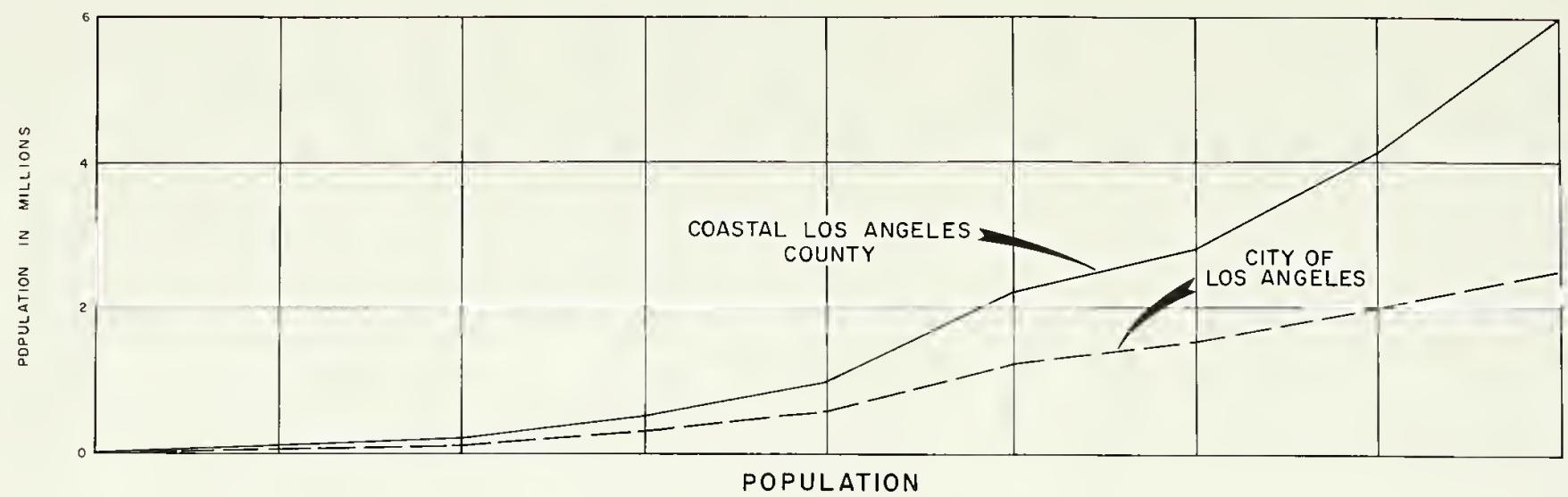


NUMERICAL DESIGNATIONS OF HYDROLOGIC UNITS AND SUBUNITS

4-11.00	Los Angeles Coastal Plain Unit
4-11.01	Santa Monica Subunit
4-11.02	West Coast Basin Subunit
4-11.03	Central Basin Pressure Subunit
4-11.04	Los Angeles Forebay Subunit
4-11.05	Montebello Forebay Subunit
4-11.06	Hollywood Subunit
4-11.08	Whittier Subunit
4-11.09	Palos Verdes Subunit
4-12.00	San Fernando Unit
4-12.01	San Fernando Subunit
4-12.02	Bull Canyon Subunit
4-12.03	Sylmar Subunit
4-12.04	Pacoma Subunit
4-12.05	Tujunga Subunit
4-12.06	Little Tujunga Subunit
4-12.07	Verdugo Subunit
4-13.00	San Gabriel Unit
4-13.01	Main San Gabriel Valley Subunit
4-13.02	Monk Hill Subunit
4-13.03	Pasadena Subunit
4-13.04	Santa Anita Subunit
4-13.05	Upper Canyon Subunit
4-13.06	Lower Canyon Subunit
4-13.07	Glendora Subunit
4-13.08	Way Hill Subunit
4-13.09	San Dimas Subunit
4-13.10	Foothill Subunit
4-13.12	Puente Subunit
4-14.00	Upper Santa Ana Valley Unit (Los Angeles County)
4-14.01	Chino Subunit
4-14.02	Potona Subunit
4-14.03	Live Oak Subunit
4-14.04	Claremont Heights Subunit
4-14.05	Spadra Subunit
4-15.00	Malibu Unit
4-15.01	Hidden Valley Subunit
4-15.02	Russell Valley Subunit
4-15.03	Big Sycamore Canyon Subunit
4-15.04	Little Sycamore Canyon Subunit
4-15.05	Arroyo Sequit Subunit
4-15.06	Nicholas Canyon Subunit
4-15.07	Los Alisos Canyon Subunit
4-15.08	Encinal Canyon Subunit
4-15.09	Trancas Canyon Subunit
4-15.10	Zuma Canyon Subunit
4-15.11	Ramera Canyon Subunit
4-15.12	Escondido Canyon Subunit
4-15.13	Latigo Canyon Subunit
4-15.14	Solstice Canyon Subunit
4-15.15	Corral Canyon Subunit
4-15.16	Malibu Creek Subunit
4-15.17	Triunfo Canyon Subunit
4-15.18	Carbon Canyon Subunit
4-15.19	Las Flores Canyon Subunit
4-15.20	Piedre Corda Canyon Subunit
4-15.21	Pena Canyon Subunit
4-15.22	Tuna Canyon Subunit
4-15.23	Topanga Canyon Subunit
4-15.24	Lindero Canyon Subunit
4-15.25	Las Virgenes Canyon Subunit
4-15.26	Deer Canyon Subunit
4-15.27	La Jolla Valley Subunit
4-17.00	Orange County Coastal Plain Unit (Los Angeles County)
4-17.01	La Habra Subunit
4-17.02	Yorba Linda Subunit

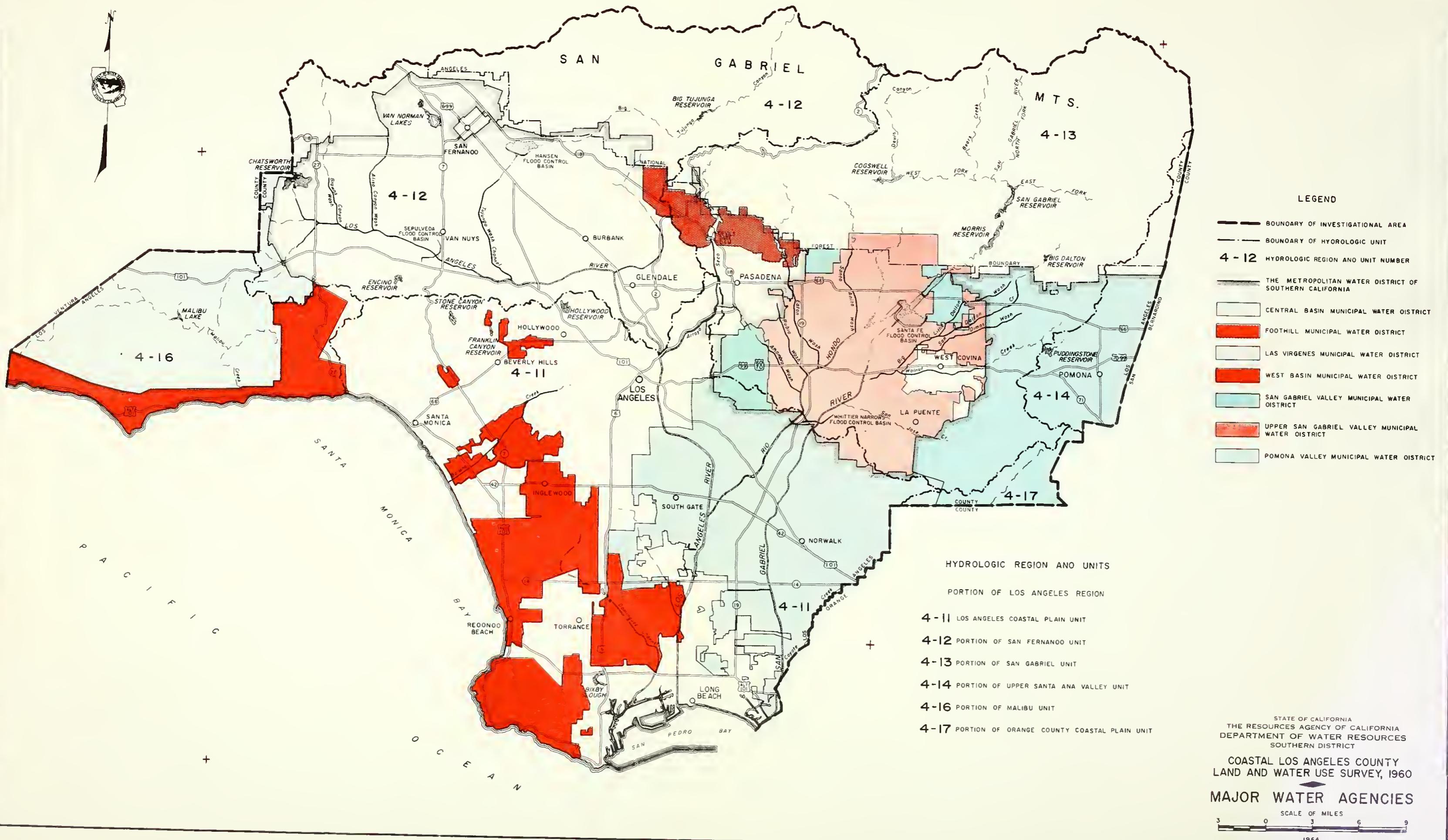






HISTORICAL POPULATION AND LAND USE  
IN COASTAL LOS ANGELES COUNTY

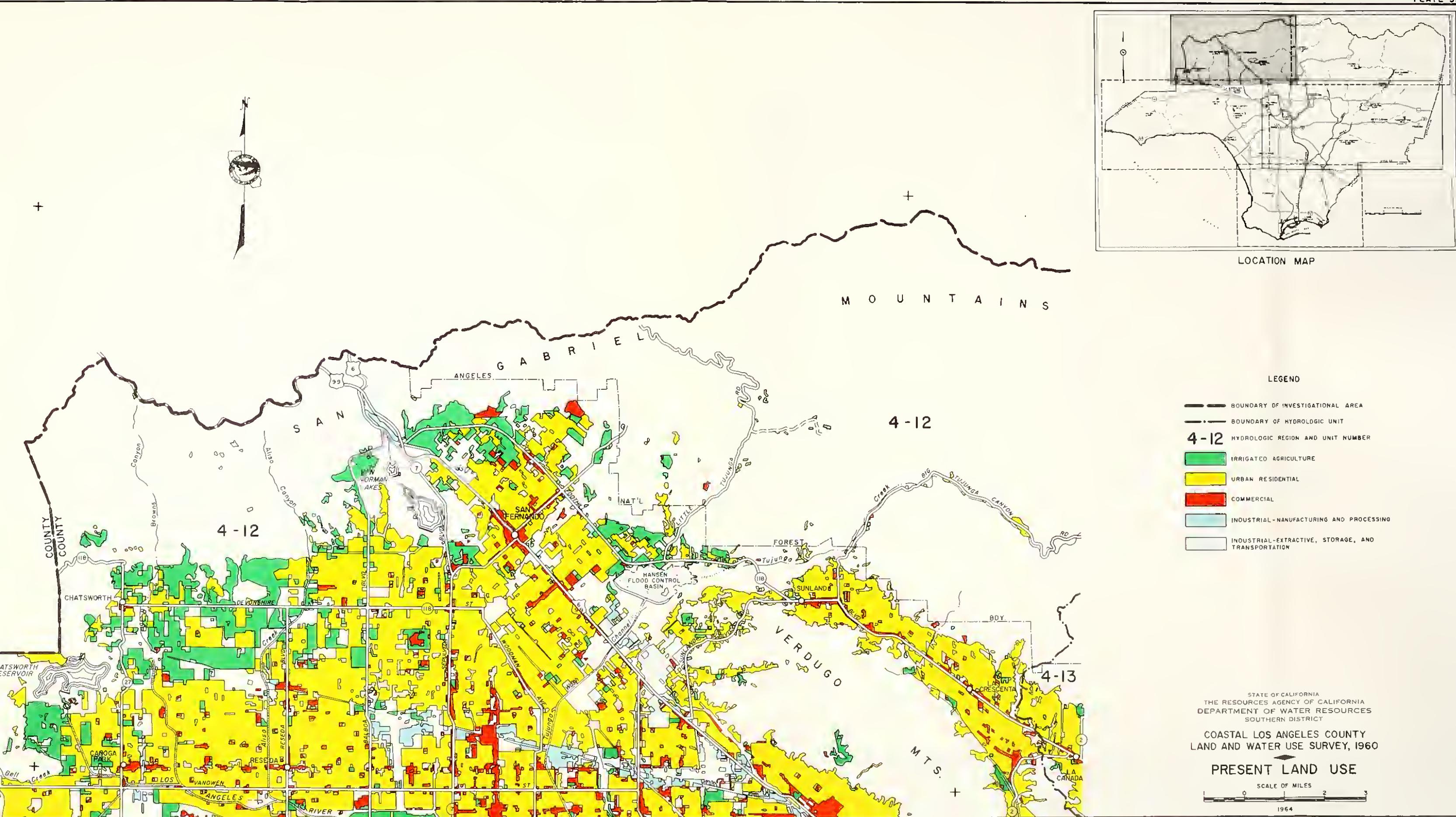






## HYDROLOGIC AREA AND UNITS

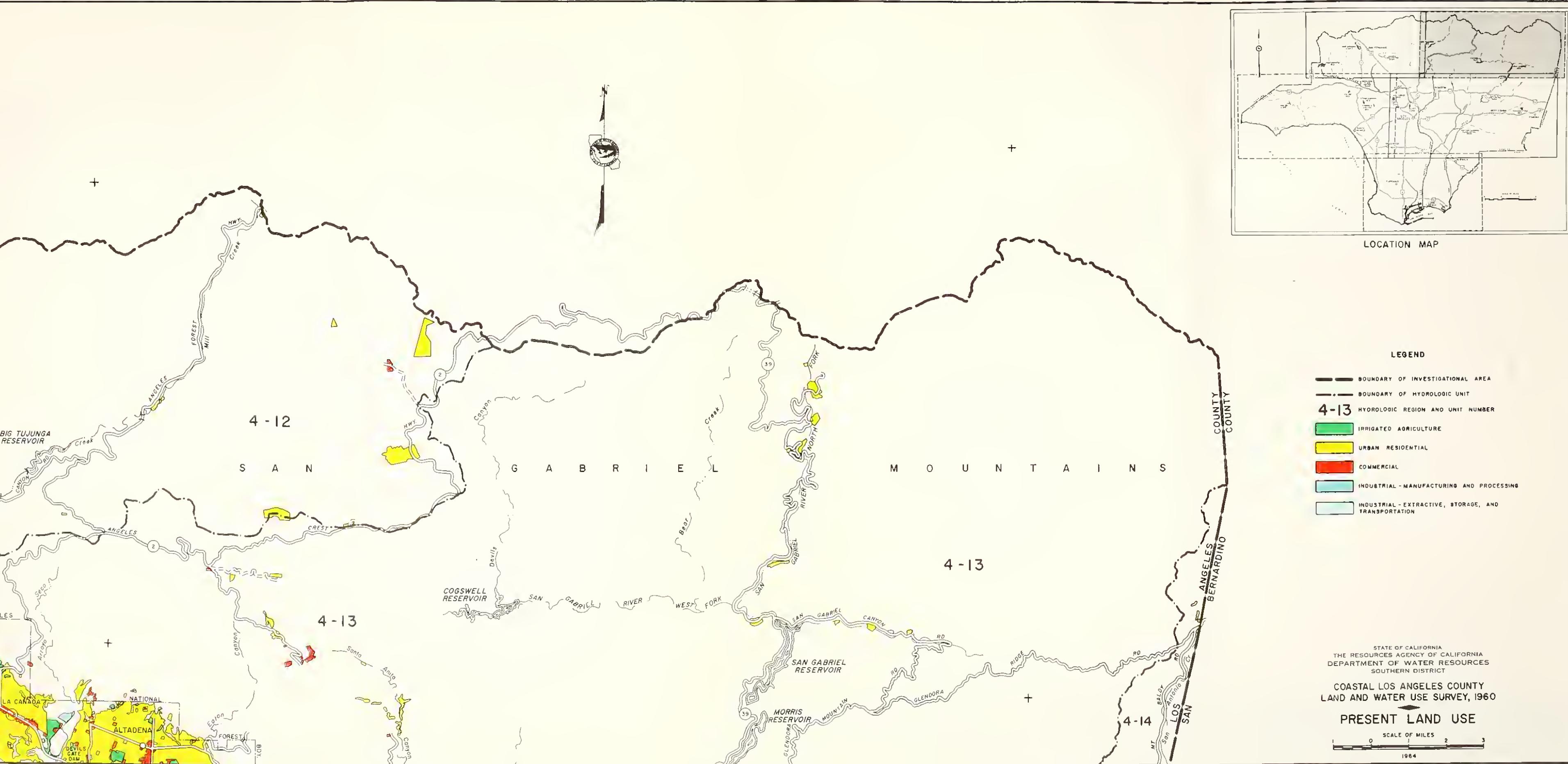
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 4-11 LOS ANGELES COASTAL PLAIN UNIT  
 4-12 SAN FERNANDO UNIT  
 4-13 SAN GABRIEL UNIT  
 4-14 UPPER SANTA ANA VALLEY UNIT  
 4-16 MALIBU UNIT  
 4-17 ORANGE COUNTY COASTAL PLAIN UNIT





## HYDROLOGIC AREA AND UNITS

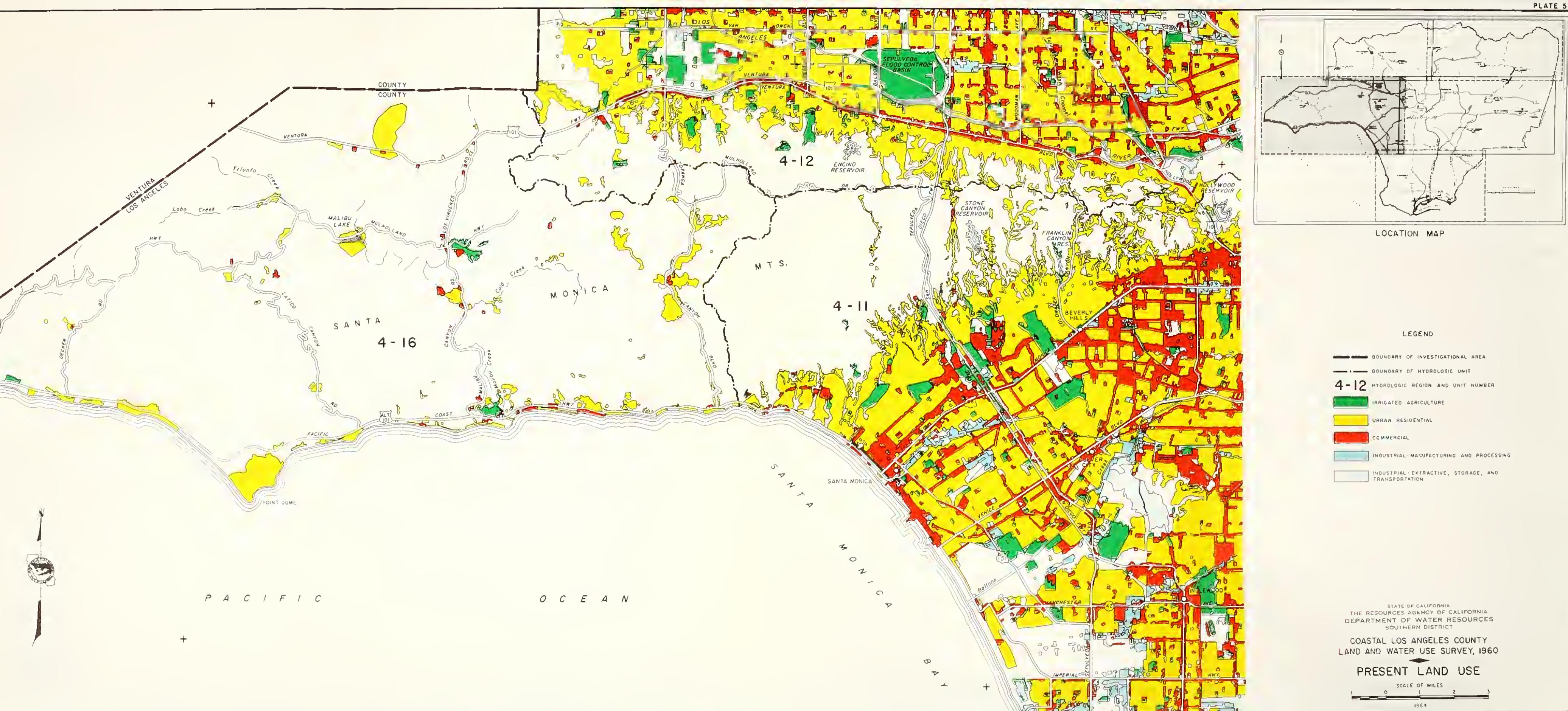
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## HYDROLOGIC AREA AND UNITS

- 4-0 PORTION OF LOS ANGELES HYDROLOGIC AREA  
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 4-12 SAN FERNANOO UNIT  
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 4-14 UPPER SANTA ANA VALLEY UNIT  
 4-16 MALIBU UNIT  
 4-17 ORANGE COUNTY COASTAL PLAIN UNIT





## HYDROLOGIC AREA AND UNITS

- 4 - 0 PORTION OF LOS ANGELES HYDROLOGIC AREA

4-11 LOS ANGELES COASTAL PLAIN UNIT

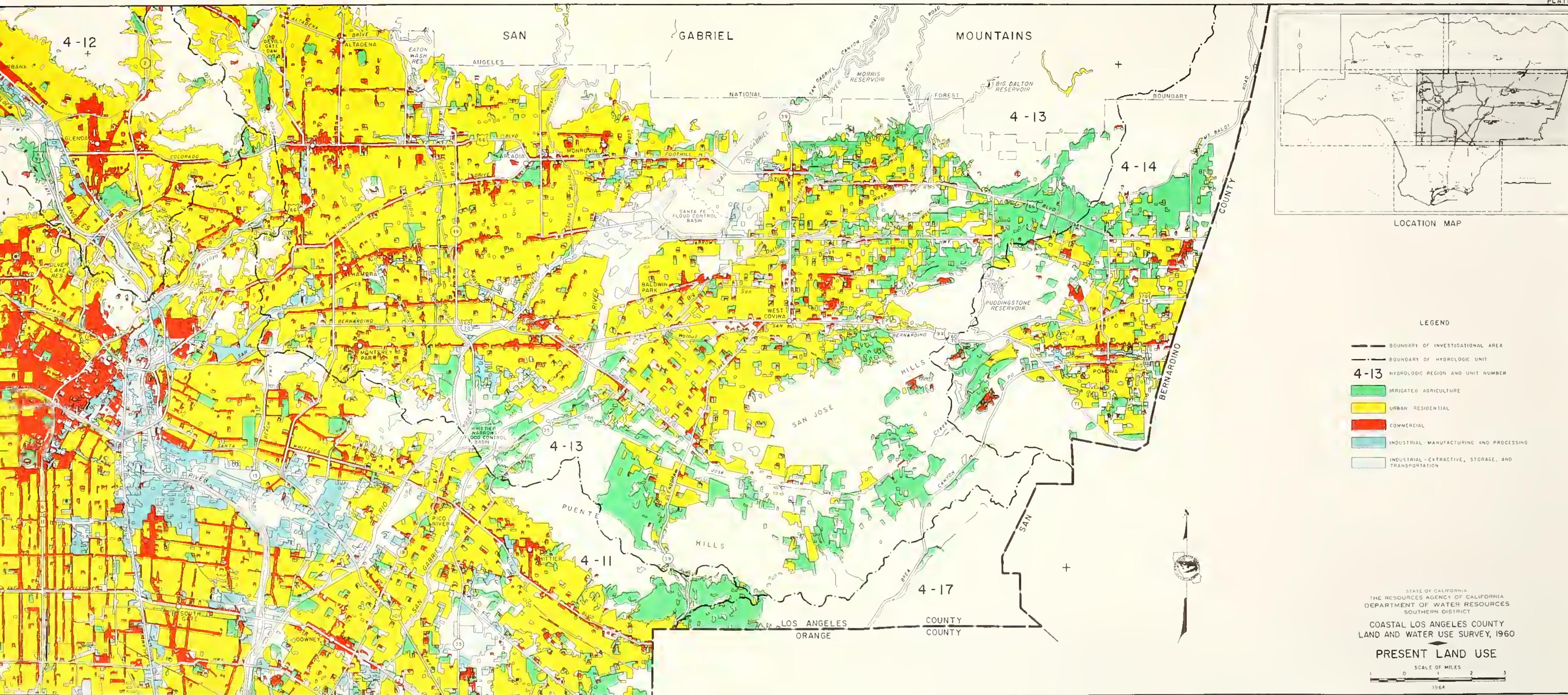
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4-13 SAN GABRIEL UNIT

4-14 UPPER SANTA ANA VALLEY UNIT

4-16 MALIBU UNIT

4-17 ORANGE COUNTY COASTAL PLAIN UNIT

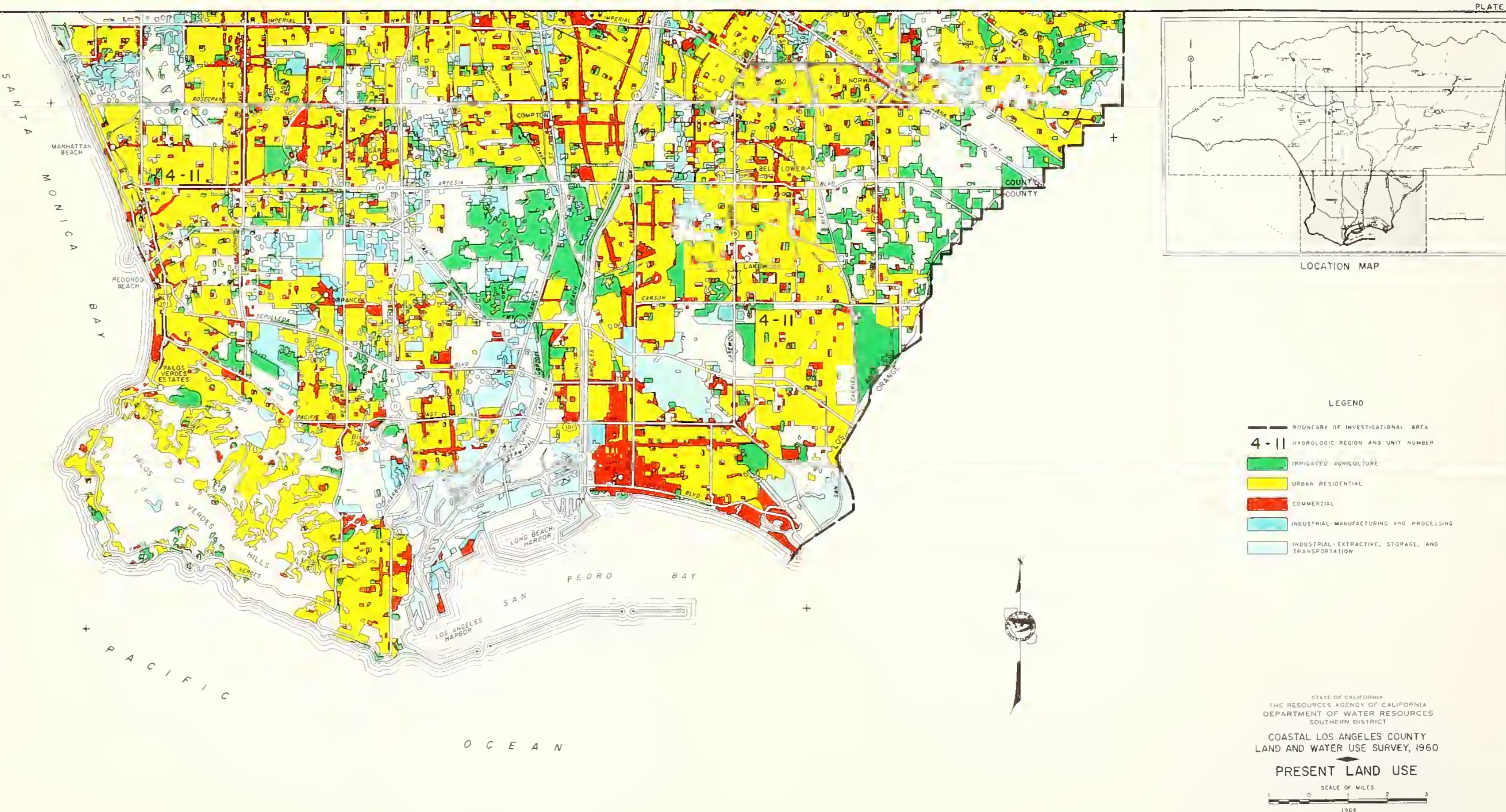




## HYDROLOGIC AREA AND UNITS

4-0 PORTION OF LOS ANGELES HYDROLOGIC AREA

- 4-11 LOS ANGELES COASTAL PLAIN UNIT
- 4-12 SAN FERNANDO UNIT
- 4-13 SAN GABRIEL UNIT
- 4-14 UPPER SANTA ANA VALLEY UNIT
- 4-16 MALIBU UNIT
- 4-17 ORANGE COUNTY COASTAL PLAIN UNIT





## HYDROLOGIC AREA AND UNITS

- 4 - 0 PORTION OF LOS ANGELES HYDROLOGIC AREA

4-11 LOS ANGELES COASTAL PLAIN UNIT

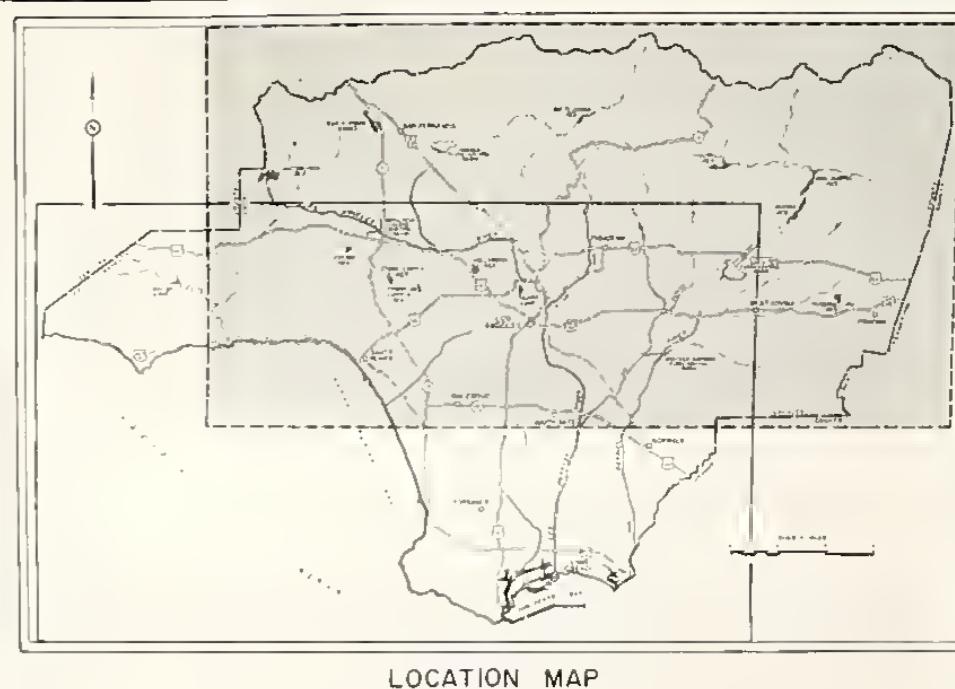
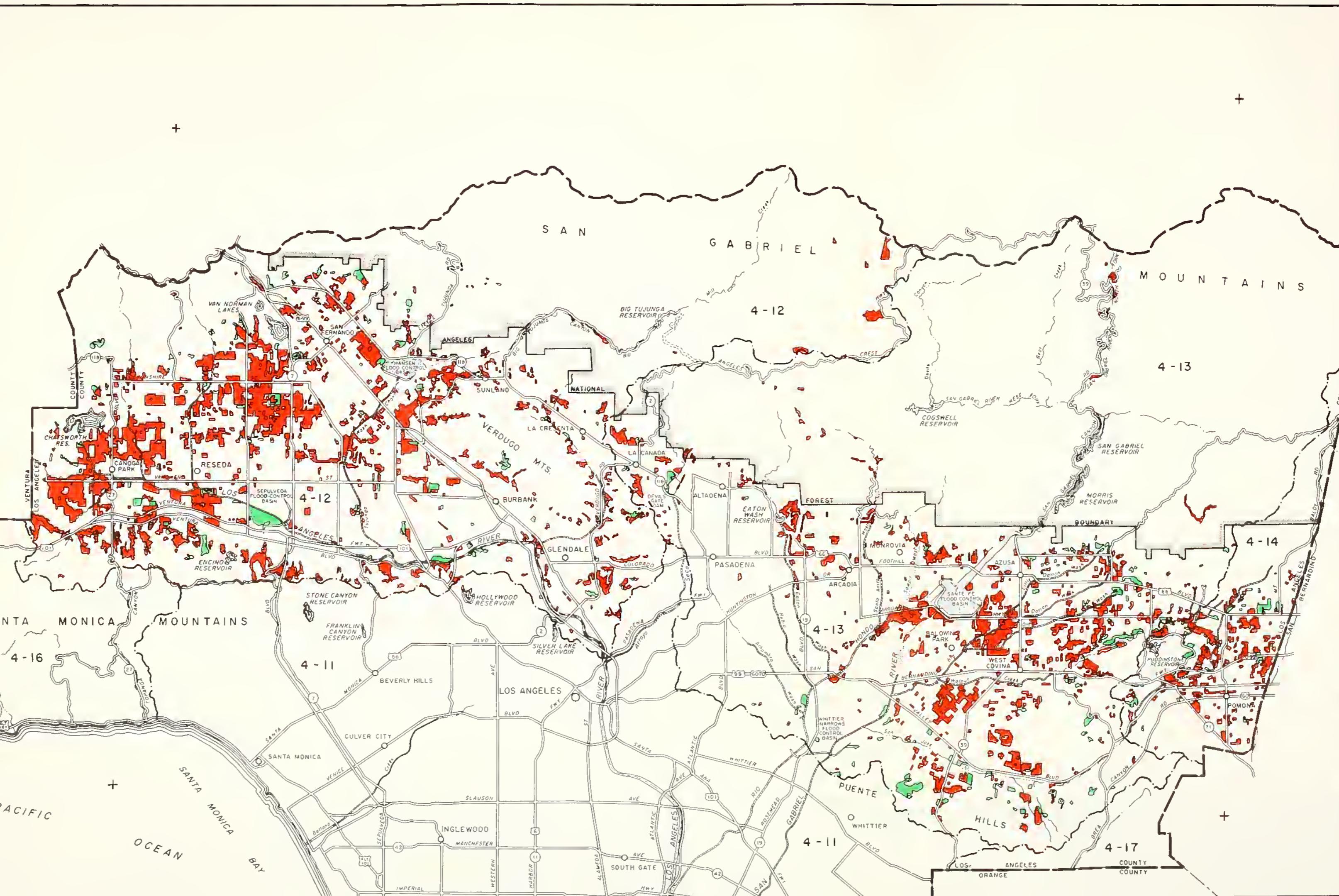
4-12 SAN FERNANDO UNIT

4-13 SAN GABRIEL UNIT

4-14 UPPER SANTA ANA VALLEY UNIT

4-16 MALIBU UNIT

4-17 ORANGE COUNTY COASTAL PLAIN UNIT



#### **LOCATION**

**LEGEND**

- BOUNDARY OF INVESTIGATIONAL AREA  
— BOUNDARY OF HYDROLOGIC UNIT  
**4-16** HYDROLOGIC REGION AND UNIT NUMBER  
■ IRRIGATED AGRICULTURAL EXPANSION  
■ URBAN AND SUBURBAN AREAS  
■ CHANGE IN LAND USE, 1950 TO 1960

STATE OF CALIFORNIA  
THE RESOURCES AGENCY OF CALIFORNIA  
DEPARTMENT OF WATER RESOURCES  
SOUTHERN DISTRICT

COASTAL LOS ANGELES COUNTY  
LAND AND WATER USE SURVEY, 1960  
CHANGE IN LAND USE  
1955 TO 1960

SCALE OF MILES  
2 0 2 4  
1954

## HYDROLOGIC AREA AND UNITS

**4 - O PORTION OF LOS ANGELES HYDROLOGIC AREA**

## **4-11 LOS ANGELES COASTAL PLAIN UNIT**

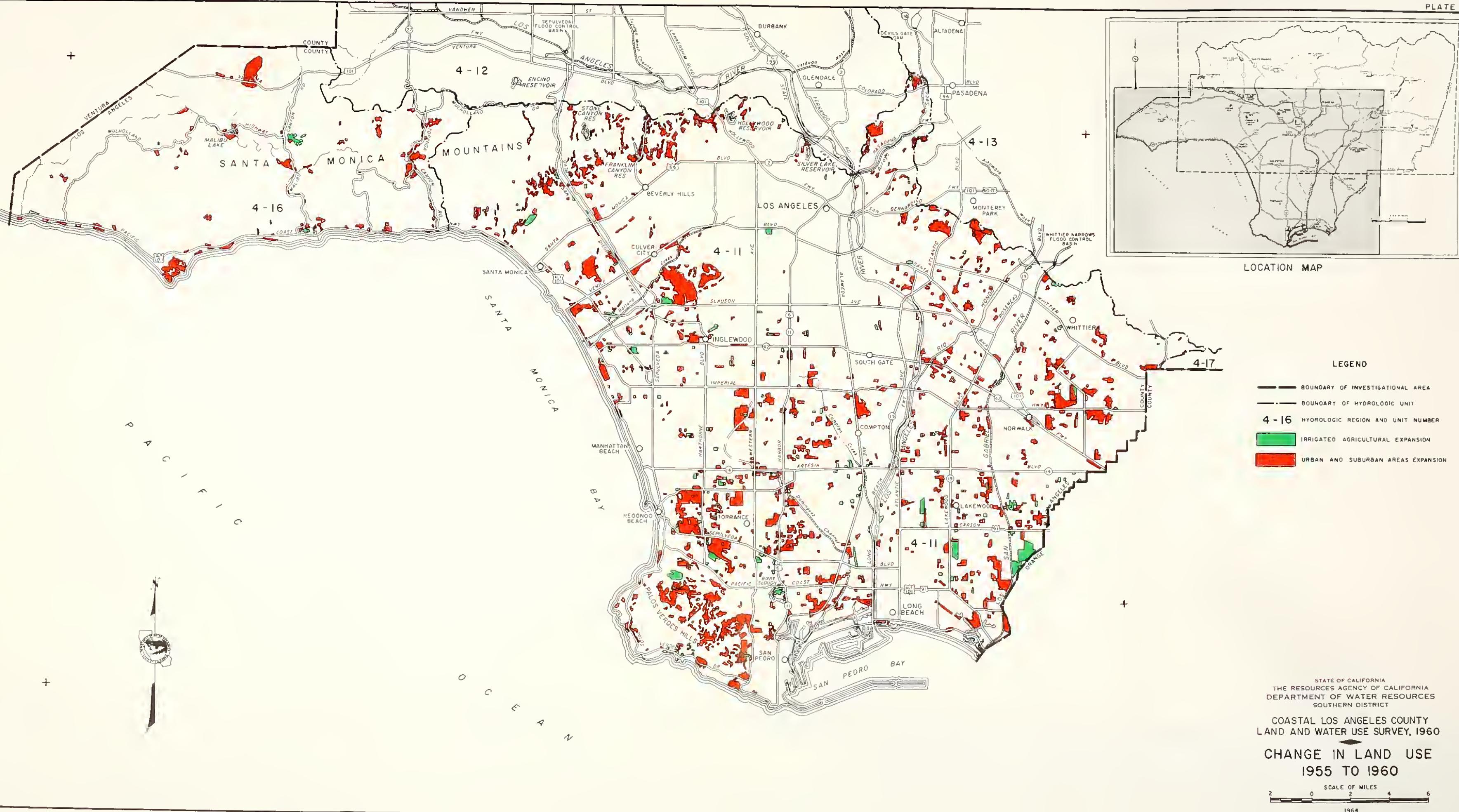
## **4 - 12 SAN FERNANDO UNIT**

**4-13 SAN GABRIEL UNIT**

## **4-14 UPPER SANTA ANA VALLEY UNIT**

## 4-16 MALIBU UNIT

## **4-17 ORANGE COUNTY COASTAL PLAIN UNIT**



**APPENDIX A**  
**DEFINITION OF TERMS**



## APPENDIX A

### DEFINITION OF TERMS

Annual - The 12-month period from January 1 of a given year through December 31 of the same year, sometimes termed the "calendar year."

Applied Water - Water delivered to a farmer's headgate, in the case of irrigation use, or to an individual's meter in the case of urban use, or its equivalent. It does not include direct precipitation.

Applied Water Requirement - The applied water needed to provide for all beneficial uses and for irrecoverable losses incidental to such uses. It excludes that portion of the requirement which is provided by rainfall.

Approximate Seasonal Safe Yield of Local Water Supplies - For this study the "Approximate Seasonal Safe Yield of Local Water Supplies" is the average seasonal amount of local water, excluding all imported water, which could be used over a long-term period without causing a net change in storage of water supplies. The safe yield for this study was based on 1960 conditions of cultural development and water use and disposal.

Aquifer - A geologic formation or structure sufficiently permeable to yield an appreciable supply of water to wells or springs.

Average - An arithmetical average relating to a period other than a mean period.

Confined Ground Water - A body of ground water immediately overlain by material sufficiently impervious to sever free hydraulic connection with overlying water, and moving under pressure caused by the

difference in head between the intake or forebay area and the discharge area of the confined water body.

Consumptive Use of Water - Water consumed by vegetative growth in transpiration and building plant tissue, and water evaporated from adjacent soil, from water surface, and from foliage. It also includes water similarly consumed and evaporated by urban and nonvegetative types of land use.

Free Ground Water - A body of ground water not immediately overlain by impervious materials.

Ground Water Overdraft - The rate of net extraction of water from a ground water basin in excess of safe ground water yield.

Hydrologic Unit - A major watershed area including water-bearing and nonwater-bearing formations.

Irrigation Efficiency - The ratio of consumptive use of applied irrigation water to the total amount of water applied, expressed as a percentage.

Mean - An arithmetical average relating to a mean period.

Mean Period - A period chosen to represent conditions of water supply and climate over a long series of years. For purposes of the current investigation, the mean precipitation period embraces the 50 seasons from 1897-98 through 1946-47, and the mean runoff period, the 53 seasons from 1894-95 through 1946-47.

Net Water Use - "Net water use" is defined as that portion of the applied water which is consumptively utilized for beneficial purposes or irrecoverably lost. It does not include that portion of the applied water which is subject to possible reuse.

Present - Land use and water supply conditions prevailing during the 1959-60 season.

Seasonal - Any 12-month period other than the calendar year.

Water Requirement - The water needed to provide for all beneficial uses and for all irrecoverable losses incidental to such uses.

Water Utilization - This includes all employments of water by nature or man, whether consumptive or nonconsumptive, as well as irrecoverable losses of water incidental to such employment, and is synonymous with the term "water use."



**APPENDIX B**

**LIST OF  
RELATED REPORTS**



## APPENDIX B

### LIST OF RELATED REPORTS

The following reports contain information pertinent to land and water use within Coastal Los Angeles County:

Bookman, M., Edmonston, R. M. "Annual Survey Report on Ground Water Replenishment." Central and West Basin Water Replenishment District. 1963.

California Department of Public Works, Division of Water Resources, "Report of Referee, City of Pasadena, a Municipal Corporation, vs. City of Alhambra, a Municipal Corporation, et al. Case No. Pasadena C-1323, Superior Court, Los Angeles County." (Raymond Basin Reference). July 1943.

---- "South Coastal Basin Investigation, Overdraft on Ground Water Basins." Bulletin No. 53. 1947.

California Department of Water Resources. "Investigation of Alternative Aqueduct Systems to Serve Southern California, Appendix D, Economic Demand for Imported Water." Bulletin No. 78, March 1960.

---- "Planned Utilization of the Ground Water Basins of the Coastal Plain of Los Angeles County. Appendix B, Safe Yield Determinations." Bulletin No. 104, April 1962.

California State Water Rights Board. "Report of Referee, the City of Los Angeles, a Municipal Corporation, vs. the City of San Fernando, a Municipal Corporation, et al., Case No. 650079, Superior Court, Los Angeles County." (San Fernando Valley Reference). July 1962.

Los Angeles Chamber of Commerce. "The Researcher, 1961-62 Statistical Summary." No date.

Los Angeles County Regional Planning Commission. "Population and Dwelling Units." Quarterly Bulletin No. 77, July 1, 1962.

Metropolitan Water District of Southern California. "Twenty-second Annual Report." 1960, and "Twenty-third Annual Report." 1961.

Southern California Research Council. "The Southern California Metropolis-1980." 1959.

United States Department of Commerce, Bureau of the Census. "U. S. Censuses of Population and Housing 1960. Census Tracts." Final Report PHC (1)-82. 1962.



APPENDIX C

LAND USE IN HYDROLOGIC  
SUBUNITS OF COASTAL  
LOS ANGELES COUNTY, 1960



## APPENDIX C

LAND USE IN HYDROLOGIC SUBUNITS OF  
COASTAL LOS ANGELES COUNTY, 1960

In acres

Category and class of land use	Los Angeles Coastal Plain					
	Hydrologic Unit Subunits					
	Santa Monica : West Coast Basin	Central Basin	Los Angeles : Pressure	Montebello : Forebay	Hollywood : Forebay	Whittier : Palos Verdes
<u>WATER SERVICE AREA</u>						
<u>Urban and Suburban</u>						
Residential	16,300	33,070	46,910	19,620	10,810	9,110
Commercial	1,490	3,320	4,920	4,270	950	1,210
Industrial	1,130	7,740	5,050	5,620	1,530	270
Unsegregated urban and suburban area	2,420	4,330	2,110	2,150	1,480	440
Subtotals	21,340	48,460	65,990	31,660	14,770	11,030
Included Nonwater Service Area	10,050	39,280	33,150	14,590	9,350	4,020
Gross Urban and Suburban Area	31,390	87,740	99,140	46,250	24,120	15,050
<u>IRRIGATED AGRICULTURE</u>						
<u>Alfalfa</u>	0	10	550	0	10	0
Pasture	10	10	1,320	0	40	0
Citrus and subtropical	40	10	60	0	160	20
Truck crops	390	2,930	1,660	220	180	170
Field crops	120	80	430	0	30	0
Deciduous fruits and nuts	0	10	*	0	30	*
Small grains	0	*	200	0	*	10
Vineyards	0	0	0	0	0	0
Subtotals	560	3,050	4,220	220	450	190
Pallow	10	1,090	680	0	70	10
Included Nonwater Service Area	30	190	250	10	110	10
Gross Irrigated Agriculture	600	4,330	5,150	230	630	210
GROSS WATER SERVICE AREA	31,990	92,070	104,290	46,480	24,750	15,260
<u>NONWATER SERVICE AREA</u>						
<u>Nonirrigated Agriculture</u>	600	4,380	1,300	0	170	0
Native Vegetation	540	2,500	1,870	360	2,030	1,360
Unclassified	21,510	3,550	270	370	1,410	540
GROSS NONWATER SERVICE AREA	22,650	10,430	3,440	730	3,610	6,810
TOTALS	54,640	102,500	107,730	47,210	28,360	22,070

\*Less than five acres.

LAND USE IN HYDROLOGIC SUBUNITS OF  
COASTAL LOS ANGELES COUNTY, 1960  
(continued)

In acres

Category and class of land use	San Fernando Hydrologic Unit						San Gabriel Hydrologic Unit					
	Subunits	Subunits	Subunits	Subunits	Subunits	Subunits	Subunits	Subunits	Subunits	Subunits	Subunits	Subunits
WATER SERVICE AREA												
Urban and Suburban												
Residential	53,580	290	1,550	560	3,250	70	3,520	62,820	34,870	3,640		
Commercial	3,560	*	90	20	0	0	170	4,030	2,400	1,30		
Industrial	3,070	30	60	*	20	0	10	3,190	1,650	40		
Unsegregated urban and suburban area	5,990	20	310	30	180	50	270	6,850	4,240	290		
Subtotals	66,200	340	2,010	610	3,640	120	3,970	76,890	43,160	4,100		
Included Nonwater Service Area	41,130	100	1,590	490	2,700	70	1,320	47,400	24,630	1,440		
Gross Urban and Suburban Area	107,330	440	3,600	1,100	6,340	190	5,290	124,290	67,790	5,540		
IRRIGATED AGRICULTURE												
Alfalfa	750	0	0	0	0	0	0	0	750	120	0	
Pasture	860	0	0	0	0	0	0	860	670	0		
Citrus and subtropical	3,260	510	970	210	160	*	20	5,130	1,430	20		
Truck crops	1,060	40	130	30	300	0	*	1,560	700	40		
Field crops	420	0	0	0	10	0	0	430	170	0		
Deciduous fruits and nuts	460	0	20	0	40	*	20	540	140	*		
Small grains	90	0	0	0	0	0	0	90	100	0		
Vineyards	40	*	20	0	*	—	—	60	0	0		
Subtotals	6,940	550	1,140	240	510	0	40	9,420	3,330	60		
FALLOW	780	80	40	40	140	0	0	1,080	240	0		
Included Nonwater Service Area	680	90	60	10	60	10	*	910	460	10		
GROSS IRRIGATED AGRICULTURE	8,400	720	1,240	290	710	10	40	11,410	4,020	70		
GROSS WATER SERVICE AREA	115,730	1,160	4,840	1,390	7,050	200	5,330	135,700	71,820	5,610		
NONWATER SERVICE AREA												
Nonirrigated Agriculture	1,390	420	0	0	160	50	10	2,030	1,720	10		
Native vegetation	3,690	7,300	1,800	1,700	1,250	5,620	500	21,860	5,950	780		
Unclassified	44,260	5,190	5,230	19,740	77,240	8,220	7,870	169,450	10,330	15,920		
GROSS NONWATER SERVICE AREA	50,040	12,910	7,730	21,440	78,250	13,890	8,380	193,340	18,000	16,780		
TOTALS	165,770	14,070	12,570	22,830	86,000	14,090	13,710	329,040	89,820	22,390		

\*Less than five acres.

LAND USE IN HYDROLOGIC SUBUNITS OF  
COASTAL LOS ANGELES COUNTY, 1960  
(continued)

In acres

Category and class of land use	San Gabriel Hydrologic Unit Subunits						Total Unit			
	Pasadena	Santa Anita	Upper Canyon	Lower Canyon	Glendora	Way Hill	San Dimas	Foothill	Puente	
<b>WATER SERVICE AREA</b>										
<u>Urban and Suburban</u>										
Residential	9,390	1,560	400	400	1,260	400	680	80	1,920	54,600
Commercial	510	40	30	80	70	*	30	0	70	3,360
Industrial	360	0	0	30	30	10	30	0	170	2,370
Unseggregated urban and suburban area	830	80	30	40	250	130	200	20	510	6,620
Subtotals	11,090	1,680	460	600	1,610	540	940	100	2,670	66,950
Included Nonwater Service Area	4,050	500	340	480	910	440	700	70	1,710	35,270
Gross Urban and Suburban Area	15,140	2,180	800	1,030	2,520	980	1,640	170	4,380	102,220
<b>Irrigated Agriculture</b>										
Alfalfa	0	0	0	0	0	0	0	0	130	250
Pasture	0	0	0	0	50	50	10	0	540	1,320
Citrus and subtropical	90	30	120	180	700	470	2,240	420	2,900	8,600
Truck crops	70	10	20	170	*	40	20	0	550	1,620
Field crops	0	0	0	0	0	0	0	0	60	230
Deciduous fruits and nuts	0	0	0	0	0	10	0	0	500	730
Small grains	0	0	0	0	0	0	10	0	20	130
Vineyards	0	0	0	0	0	0	0	0	0	*
Subtotals	160	40	140	350	760	570	2,270	420	4,780	12,880
Fallow	*	0	*	10	0	50	0	0	20	320
Included Nonwater Service Area	10	—	20	50	210	50	460	50	520	1,840
Gross Irrigated Agriculture	170	40	160	410	970	670	2,730	470	5,320	15,040
GROSS WATER SERVICE AREA	15,310	2,220	960	1,490	3,490	1,650	4,370	640	9,700	117,260
<b>NONWATER SERVICE AREA</b>										
Nonirrigated Agriculture	10	0	10	0	70	10	350	220	5,260	7,660
Native vegetation	1,000	230	1,330	520	510	250	450	900	1,710	13,630
Unclassified	7,560	10,330	146,820	260	9,880	820	2,080	13,620	13,610	231,360
GROSS NONWATER SERVICE AREA	8,570	10,560	148,160	780	10,460	1,080	2,880	14,740	20,580	252,590
TOTALS	23,880	12,780	149,120	2,270	13,950	2,730	7,250	15,380	30,280	369,850

\*Less than five acres.

LAND USE IN HYDROLOGIC SUBUNITS OF  
COASTAL LOS ANGELES COUNTY, 1960  
(continued)

In acres

Category and class of land use	Upper Santa Ana Valley Hydrologic Unit						Malibu Hydrologic Unit					
	Subunits			Subunits			Subunits			Subunits		
	Chino	Pomona	Live Oak	Claremont	Sedra	Total	Hidden Valley	Russell Valley	Big Valley	Sycamore Canyon	Little Canyon	
<u>WATER SERVICE AREA</u>												
<u>Urban and Suburban</u>												
Residential	2,240	1,640	350	170 *	1,260	5,660	160	0	0	*	30	
Commercial	240	160	10	0	110	480	0	0	0	0	0	
Industrial	180	80	0	40	280	370	0	0	0	0	0	
Unsegregated urban and suburban area	<u>230</u>	<u>330</u>	<u>70</u>	<u>40</u>	<u>280</u>	<u>950</u>	<u>10</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>10</u>	
Subtotals	2,890	2,210	430	210	1,720	7,460	170	0	0	0	40	
Included Nonwater Service Area	<u>1,810</u>	<u>2,010</u>	<u>430</u>	<u>220</u>	<u>1,290</u>	<u>5,760</u>	<u>130</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>10</u>	
Gross Urban and Suburban Area	4,700	4,220	860	430	3,010	13,220	300	0	0	0	50	
<u>Irrigated Agriculture</u>												
Alfalfa	0	0	0	0	20	20	0	0	0	0	0	
Pasture	10	20	0	*	110	140	550	0	0	0	0	
Citrus and subtropical	90	580	810	1,210	140	2,830	0	0	0	0	0	
Truck crops	30	10	0	90	40	170	0	30	0	0	0	
Field crops	40	0	0	0	20	60	0	0	0	0	0	
Deciduous fruits and nuts	70	30	0	0	160	260	0	0	0	*	*	
Small grains	0	0	0	0	100	100	0	0	0	0	0	
Vineyards	0	0	0	*	0	*	0	0	0	0	0	
Subtotals	240	640	810	1,300	590	3,580	550	30	0	0	0	
Fallow	0	0	0	0	0	0	0	20	0	0	0	
Included Nonwater Service Area	<u>230</u>	<u>160</u>	<u>100</u>	<u>70</u>	<u>80</u>	<u>640</u>	<u>30</u>	<u>—</u>	<u>0</u>	<u>0</u>	<u>0</u>	
Gross Irrigated Agriculture	<u>470</u>	<u>800</u>	<u>910</u>	<u>1,370</u>	<u>670</u>	<u>4,220</u>	<u>580</u>	<u>20</u>	<u>0</u>	<u>0</u>	<u>0</u>	
GROSS WATER SERVICE AREA	5,170	5,020	1,770	1,800	3,680	17,440	880	50	0	0	50	
<u>NONWATER SERVICE AREA</u>												
Nonirrigated Agriculture	800	530	40	0	210	1,580	480	1,480	150	460	20	
Native Vegetation	130	300	340	970	1,070	2,810	610	630	0	0	0	
Unclassified	<u>1,190</u>	<u>1,580</u>	<u>1,860</u>	<u>8,810</u>	<u>3,060</u>	<u>16,500</u>	<u>8,710</u>	<u>5,830</u>	<u>13,200</u>	<u>3,770</u>	<u>3,770</u>	
GROSS NONWATER SERVICE AREA	<u>2,120</u>	<u>2,410</u>	<u>2,240</u>	<u>9,780</u>	<u>4,340</u>	<u>20,890</u>	<u>2,800</u>	<u>1,2940</u>	<u>14,510</u>	<u>3,840</u>	<u>3,840</u>	
TOTALS	7,290	7,430	4,010	11,580	8,020	38,330	10,680	7,990	14,510	3,840		

\*Less than five acres.

LAND USE IN HYDROLOGIC SUBUNITS OF  
COASTAL LOS ANGELES COUNTY, 1960  
(continued)

In acres

Category and class of land use	:	:	:	Malibu					
				Hydrologic Unit					
	:	:	:	Subunits	Subunits	Subunits	Subunits	Subunits	Subunits
Arroyo	: Nicholas	: Los	: Encinal	Zuma	Pamela	Escondido	Latigo	Solstice	Canyon
Sequit	: Canyon	: Alisos	: Canyon	Canyon	Canyon	Canyon	Canyon	Canyon	Canyon
<u>WATER SERVICE AREA</u>									
<u>Urban and Suburban</u>									
Residential	10	20	10	50	40	90	100	30	20
Commercial	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0
Unsegregated urban and suburban area	0	0	*	0	0	10	0	0	0
Subtotals	10	20	10	50	40	100	100	30	20
<u>Included Nonwater-Service area</u>									
Gross Urban and Suburban Area	10	10	70	80	660	1,300	1,160	240	30
20	30	80	130	700	1,400	1,260	270	50	0
<u>Irrigated Agriculture</u>									
Alfalfa	0	0	0	0	0	0	0	0	0
Pasture	0	0	0	0	0	0	0	0	0
Citrus and subtropical	0	0	0	0	0	0	0	0	0
Truck crops	10	30	0	0	0	0	0	0	0
Field crops	0	0	0	0	0	0	0	0	0
Deciduous fruits and nuts	0	0	0	0	0	0	0	0	0
Small grains	0	0	0	0	0	0	0	0	0
Vineyards	0	0	0	0	0	0	0	0	0
Subtotals	10	30	0	0	0	0	0	0	0
Fallow	0	0	0	0	0	0	0	0	0
Included Nonwater-Service Area	0	*	0	0	0	0	0	0	0
Gross Irrigated Agriculture	10	30	0	0	0	0	0	0	0
GROSS WATER SERVICE AREA	30	60	80	130	700	1,400	1,260	270	50
<u>NONWATER-SERVICE AREA</u>									
Nonirrigated Agriculture	0	0	0	0	0	0	0	0	0
Native Vegetation	80	0	0	0	50	20	10	0	40
Unclassified	7,310	1,190	1,2960	1,850	5,840	2,290	2,080	2,050	2,870
GROSS NONWATER-SERVICE AREA	7,390	1,190	1,2960	1,850	5,840	2,340	2,100	2,060	2,910
TOTALS	7,420	1,250	2,040	1,980	6,540	6,740	3,360	2,330	2,910

\*Less than five acres.

LAND USE IN HYDROLOGIC SUBUNITS OF  
COASTAL LOS ANGELES COUNTY, 1960  
(continued)

In acres

Category and class of land use	Malibu Hydrologic Unit									
	Subunits					Subunits				
	Corral : Malibu : Triunfo : Carbon : Las : Piedra : Pena : Tuna : Topanga : Linderio	Canyon : Creek : Canyon : Canyon : Flores : Gorda : Canyon : Canyon : Canyon : Canyon			Canyon : Canyon					
<u>WATER SERVICE AREA</u>										
Urban and Suburban										
Residential	60	320	190	*	70	60	50	10	10	500
Commercial	0	30	0	0	10	10	0	0	20	10
Industrial	0	*	0	0	0	0	0	0	0	0
Unsegregated urban and suburban area	0	10	0	0	—	0	0	0	10	80
Subtotals	60	360	190	70	70	50	10	10	530	160
Included Nonwater-Service Area	10	150	120	50	20	50	—	—	390	470
Gross Urban and Suburban Area	70	510	320	120	160	100	10	10	920	630
<u>Irrigated Agriculture</u>										
Alfalfa	0	0	0	0	0	0	0	0	0	0
Pasture	0	0	0	0	0	0	0	0	0	0
Citrus and subtropical	0	*	0	0	0	0	0	0	0	0
Truck crops	0	60	0	0	0	0	0	0	0	0
Field crops	0	0	0	0	0	0	0	0	0	0
Deciduous fruits and nuts	0	10	0	0	0	0	0	0	0	0
Small grains	0	0	0	0	0	0	0	0	0	0
Vineyards	0	0	0	0	0	0	0	0	0	0
Subtotals	0	70	0	0	0	0	0	0	0	0
Pallow	0	20	0	0	0	0	0	0	0	0
Included Nonwater-Service Area	0	0	0	0	0	0	0	0	0	0
Gross Irrigated Agriculture	0	20	0	0	0	0	0	0	0	0
GROSS WATER SERVICE AREA	70	600	320	120	160	100	10	10	920	630
<u>NONWATER-SERVICE AREA</u>										
Nonirrigated Agriculture	0	90	0	0	0	0	0	*	0	0
Native Vegetation	30	420	440	0	20	0	0	0	0	1,610
Unclassified	3,690	13,390	7,950	1,630	2,750	650	570	980	1,840	11,770
GROSS NONWATER-SERVICE AREA	3,720	13,900	8,390	1,630	2,770	650	570	980	1,840	13,380
TOTALS	3,790	14,500	8,710	1,750	2,930	750	580	990	12,760	14,010

\*Less than five acres.

LAND USE IN HYDROLOGIC SUBUNITS OF  
COASTAL LOS ANGELES COUNTY, 1960  
(continued)

In acres

Category and class of land use	Malibu Hydrologic Unit Subunits				Orange County Hydrologic Unit Subunits				Total Investigational Area
	Las Virgenes Canyon	Deer Canyon	La Jolla Valley	Total Unit	La Habra	Yorba Linda	Total Unit		
<u>WATER SERVICE AREA</u>									
Urban and Suburban									
Residential	20	0	*	1,920	110	0	110	268	440
Commercial	10	0	0	80	0	0	0	28	480
Industrial	0	0	0	*	10	0	10	27	580
Unsegregated urban and suburban area	60	0	0	190	*	0	—*	35	640
Subtotals	90	0	0	2,190	120	0	120	356	140
Included Nonwater-Service Area	20	0	0	5,130	60	0	60	209	390
Gross Urban and Suburban Area	180	0	0	7,320	180	0	180	565	530
<u>Irrigated Agriculture</u>									
Alfalfa	60	0	0	60	0	0	0	1	650
Pasture	0	0	0	550	50	0	50	4	320
Citrus and subtropical	0	0	0	*	750	0	750	19	530
Truck crops	0	0	0	130	10	0	10	9	260
Field crops	0	0	0	0	0	0	0	1	380
Deciduous fruits and nuts	0	0	0	10	0	0	0	1	590
Small grains	60	0	0	60	0	0	0	5	90
Vineyards	0	0	0	0	0	0	0	0	60
Subtotals	120	0	0	810	810	0	810	38	380
Fallow	0	0	0	40	0	0	0	3	450
Included Nonwater-Service Area	10	0	0	40	80	0	80	4	330
Gross Irrigated Agriculture	130	0	0	890	890	0	890	46	160
GROSS WATER SERVICE AREA	310	0	0	8,210	1,070	0	1,070	611	690
<u>NONWATER-SERVICE AREA</u>									
Nonirrigated Agriculture	90	50	0	2,360	40	0	40	23	090
Native Vegetation	1,230	0	0	5,650	1,090	0	1,090	54	290
Unclassified	13,890	2,270	3,610	138,380	8,490	270	270	606	680
GROSS NONWATER-SERVICE AREA	15,210	2,320	3,640	146,390	9,620	270	19,590	684	060
TOTALS	15,520	2,320	3,640	154,600	10,690	970	11,660	1,295	750

\*Less than five acres.



APPENDIX D

LIST OF DISTRICTS, AREAS, AND  
UNITS FOR WHICH INDIVIDUAL  
TABULATIONS OF 1960 LAND  
USES ARE AVAILABLE



## APPENDIX D

### LIST OF DISTRICTS, AREAS, AND UNITS FOR WHICH INDIVIDUAL TABULATIONS OF 1960 LAND USES ARE AVAILABLE

Utilizing machine techniques that were developed for processing data from this survey, individual tabulations of 1960 land use can be obtained for most of the political and hydrologic subdivisions within the area of investigation. However, reasonable limitations do not permit all of these individual tabulations to be published in this report.

For those requiring more detailed information, this appendix lists all districts, areas, and units for which 1960 land use can be individually determined and tabulated by machine methods using data available in Department of Water Resources files. It should be noted that data were based on 1960 conditions, including boundaries, and have not been modified to reflect subsequent changes.

- United States Geological Survey Quadrangles
- County Water Works Districts
- Municipal Water Districts
- County Water Districts
- National Forests
- Water Conservation Districts
- Water Districts
- Flood Control Districts
- Replenishment Districts
- Incorporated Cities
- Statistical Areas
- County Sanitation Districts
- Irrigation Districts









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